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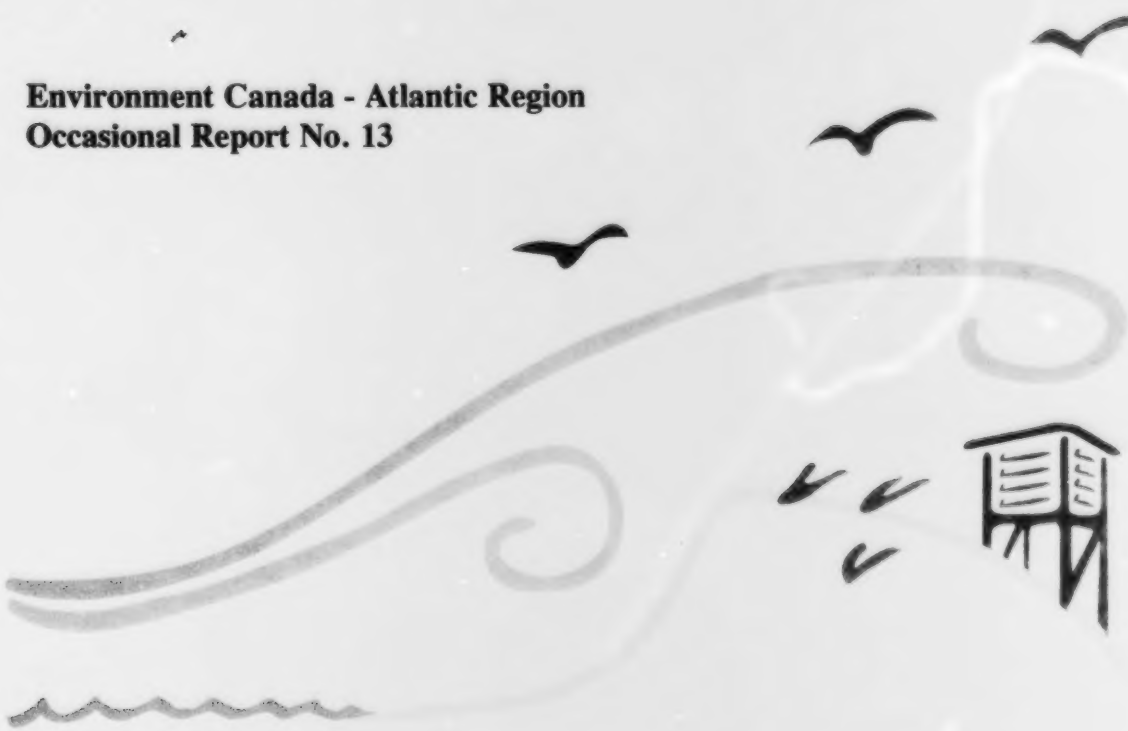
Climate Change and Ecosystem Research in Canada's North

A report to the Northern Ecosystem Initiative Management Team

Thomas A. Clair

Environment Canada - Atlantic Region
Occasional Report No. 13



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11. **Using Environmental Prediction in Ecosystem Science in Atlantic Canada, Workshop Proceedings, Halifax, N.S. (Date of Pub. Mar. 1998)**
12. **Understanding Change in the Bay of Fundy Ecosystem. Workshop Proceedings, Sackville NB (Date of Pub. April, 1999)**

Climate Change and Ecosystem Research in Canada's North: A report to the Northern Ecosystem Initiative Management Team

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1. EXECUTIVE SUMMARY

Northern Ecosystem Initiative (NEI) management requested a document which scanned the available information regarding climate change and ecosystems in the North. The objective of the work was to identify what has been done on the subject until now, and what main research needs exist. With this information in hand, the report makes recommendations to NEI management on how to make a unique and useful contribution to improving knowledge on the topic.

This task was done in several steps. First, I summarized information regarding recent changes in the climate of the North, as well as what current General Circulation Models are predicting for the region. I then scanned the Canada Country Summary Reports (CCS) (1998) to provide a summary of recent climate-related research in the North. I also summarized the regional research recommendations from the CCS which identified local knowledge shortcomings.

A further step was to send a survey to government and academic scientists, asking them what they were doing in terms of ecosystems and climate change in the North. Respondents were asked to identify what they felt were data and information shortcomings. Seventy-one replies were received, absorbed and are listed in Appendix B. Finally, an extensive literature survey was conducted to see what researchers have been doing relating climate change in the North in the past. More than one thousand reports and papers were identified and are divided into groups in Appendix C. A report section also summarily describes the title contents.

This report makes a number of recommendations for NEI managers, based on these approaches. The recommendations are broad-based and were not aimed at local or specific issues, as these were already done in the regional CCS Volumes and are reported below. These recommendations are designed to make linkages between various knowledge specialties and interests which otherwise would not occur.

The first thrust of the recommendations is for NEI to make available to ecologists, environmental and social scientists, and aboriginal people, a summary of climatological conditions in the North, along with a discussion of what climate models predict. This will sensitize interest groups to the problem, and allow them to design studies and data interpretation relating climate, climate change and ecosystems, more intelligently. A second thrust is to encourage ecosystem research which incorporates climate, climate elements or climate scientists in the design or in the

study teams. The third suggestion is to encourage the incorporation of traditional knowledge, or aboriginal concerns in the selection of projects.

2. RECOMMENDATIONS TO NEI MANAGEMENT

Based on the information gathered from the survey of Northern scientists, the bibliographical search, and from relevant portions of the Canada Country Study (CCS), a number of recommendations are made to NEI management, suggesting specific courses of action without duplicating what others are doing. The recommendations are designed to provide tools to scientists and other students of Northern ecosystems to let them better understand current and potential future climatic conditions.

Specific recommendations:

a) It is clear from the literature review that more research has been done on atmospheric and hydrologic fields than has been done on ecological topics. However, it is also clear that the climate modeling, climatology and hydrology research is poorly known by the ecological community. A priority of the NEI should be to provide a forum to expose members of the ecological and aboriginal communities to the latest climate modeling, climatology and hydrology interpretation results, along with an opportunity to question modelers regarding details of these results. This would do a number of things. First potential users of the data would get an insight into assumptions upon which models are constructed, and thus not misuse them. It would allow users an opportunity to comment on potential interactions between climate projections and their fields of interest. It would also offer modelers an opportunity to expand the use of their products. This recommendation should be dealt with, in collaboration with a Climate Change Action Fund effort currently under way.

B) Another serious need identified which would have a large benefit to a large number of users would be to better interpret historical climatological and hydrological databases for the North. This information provides the basis for much ecosystem work in the North and elsewhere. Due to the geographical scarcity of data in the area of interest, it is important that what is available be made user-friendly and easily accessible to ecosystem researchers. In particular, the NEI should commission a report describing the current and predicted climate of the region in question. Terms of reference for the report should be

prepared jointly by a climatologist and an ecologist in order to ensure that the potential information users help identify their needs.

c) The aboriginal people of the North live closely with the land. Variations in the migration patterns of waterfowl, or large mammals, changes to ice and river flow conditions will have direct consequences to their lives. Based on previous work produced by the CCS, it is important to work with them, perhaps in a workshop format, to identify ecosystem components important to their lives, and determine how sensitive to climate change these could be. It is also important to keep in mind that there will most likely be large regional differences in potential impacts. Their closeness to certain ecological indicators should help scientists determine which ones would be of greatest interest to use in traditional ecological trend studies.

d) Using this document as a starting point, open a dialogue with the other government agencies who are involved in climate change research. These include the Climate Change Action Fund (CCAF), Atmospheric Environment Service, Department of Indian and Northern Affairs, Fisheries and Oceans Canada, the National Research and Engineering Council, the Northern Climate Exchange at Yukon College, as well as other Territorial and Provincial governments. NGO groups such as aboriginal associations and University-based groups should also be consulted.

3. INTRODUCTION

Canada's North is a large region overlapping a number of ecozones and influenced by several climate systems. Though climates are dynamic and always changing, temperature seems to have been increasing in much of the Canadian North over the last few decades (Figure 1). The most dramatic rises have occurred in the winter in the Mackenzie River Basin, while winter temperatures have dropped in the Ungava and Labrador regions. The eastern Arctic shows much lower winter warming which may or may not be significant. Climate changes in the spring follow the same pattern as winter, though not as intensely, and are shown to change little in the summer and fall.

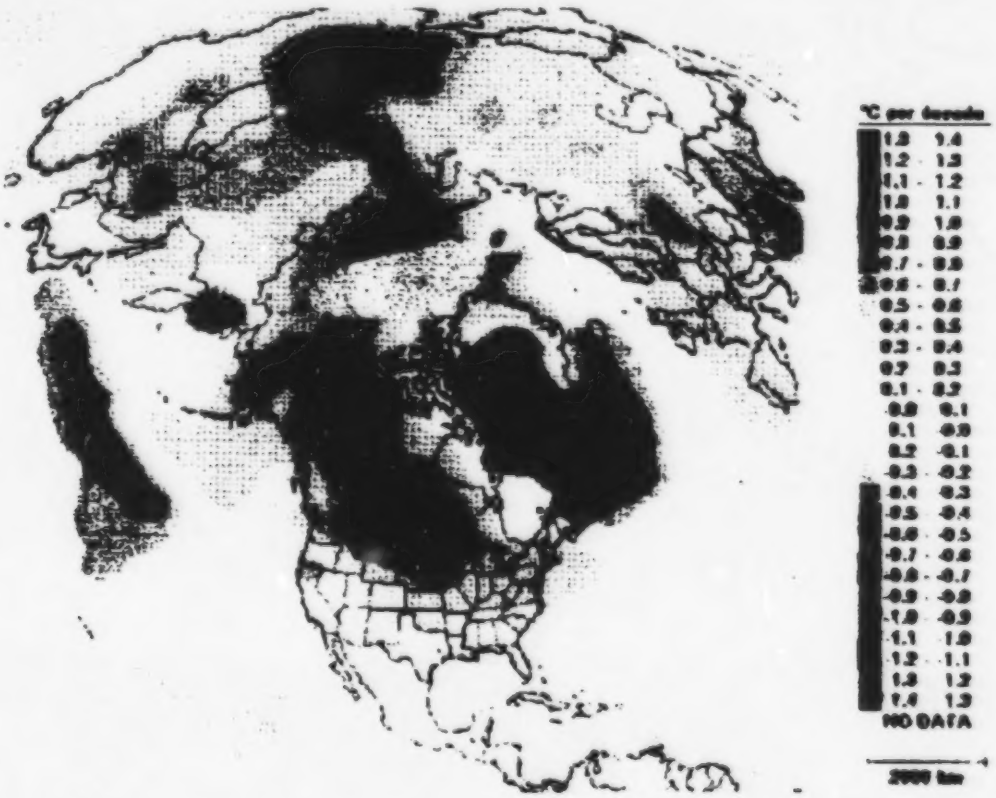


Figure 1 Measured tempetature changes between 1961 and 1990. (from UK Climatic Change Unit, Univ. of East Anglia).

There is no current agreement on exactly what causes the increase in one region, while the other region decreases. It is clear though, that climate dynamics are complex in the Canadian North, and that this complexity is enhanced by the large surface area which is involved. Recent General Circulation Model results also predict important temperature changes for the Canadian North in the future (Fig. 2). Temperature in the northern parts of Canada will most likely increase faster than in the rest of the continent, though some parts of the Labrador coast will not show much change. Though Figure 2 provides an annual average estimate, seasonal projections continue the trend measured until now of warmer winters and springs compared to summers and falls. This therefore suggests that springs will come earlier and winter will arrive later than is currently the case in the North.

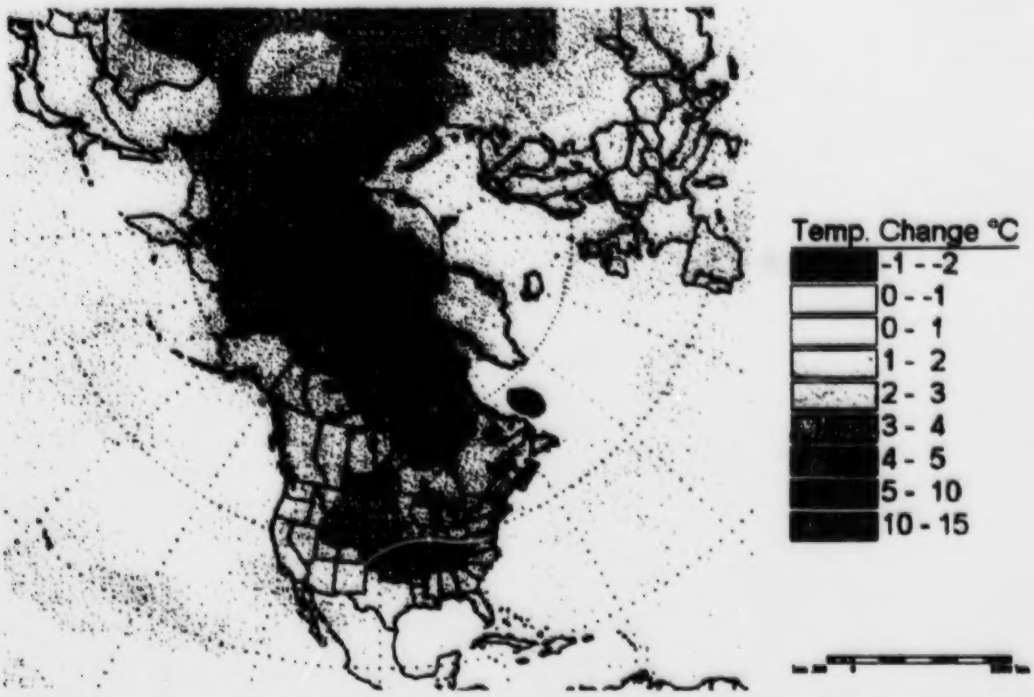


Figure 2 Projected temperature change between 1975-95 and 2040-2060. (Canadian Climate Centre Model, Environment Canada).

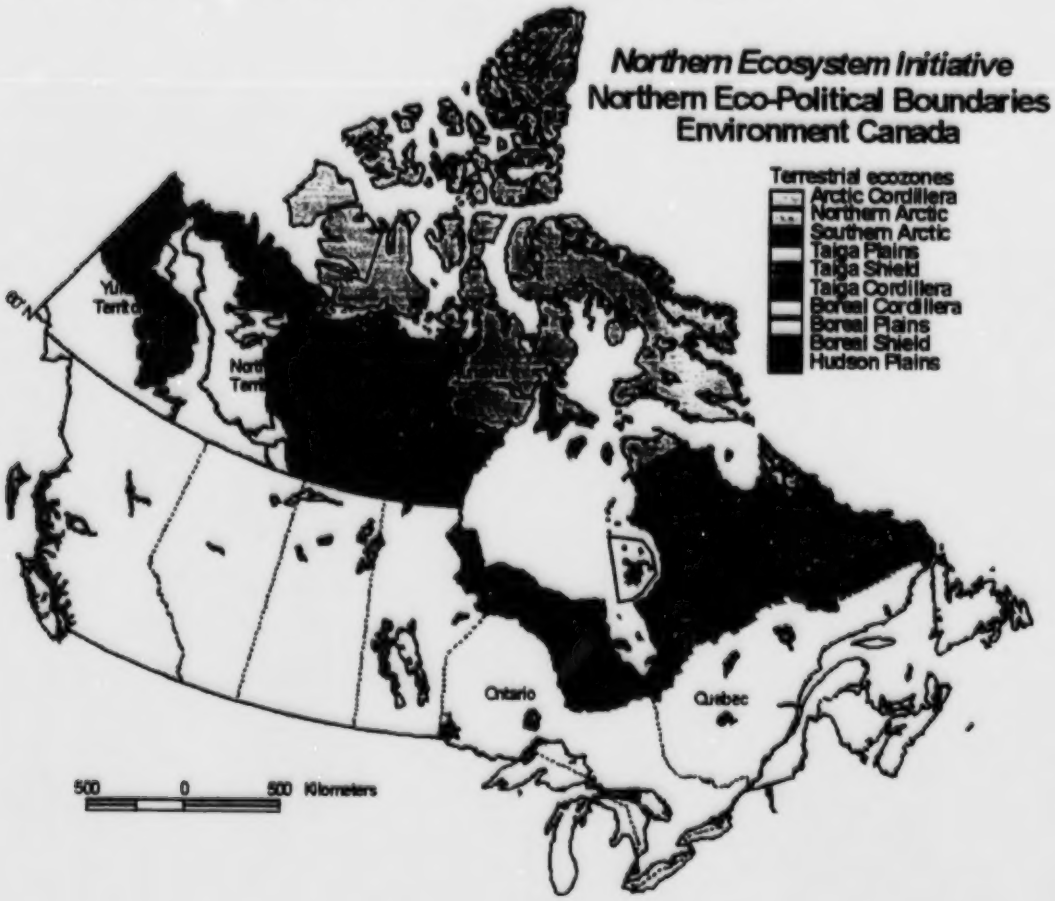
Will these changes in temperature conditions (as well as precipitation) have measurable effects on ecosystems? Because of the complexity of climate patterns, especially considering the differences between the eastern and western Arctic, it is clear that some generalizations about

ecological effects can be made for all of Canada, but that a number of regional conditions will also be at play. This report will attempt to discuss this issue following the following methodology. First, it will summarize regional sensitivities to climate change as well as the major knowledge shortcomings, and research recommendations, as were identified in the Canada Country Study (CCS), as well as from other sources which were identified over the course of the report preparation.

Secondly, the results of a survey of science experts will be summarized to identify what kind of research is currently being done and what they feel are the most important data shortcomings. Third, a literature search of environmental publications relating to climate change will be reviewed. This information will be used to determine where most of the science emphasis has been placed in the past, and which elements have been least studied and thus may need more emphasis.

With the information gathered above, this report will provide two types of outputs. The first will be to identify critical shortcomings in our knowledge base concerning ecological processes and climate in the North. The second will be to provide recommendations to NEI management as to what kind of research or information gathering they could support, to allow scientists, aboriginal groups, and decision makers to better understand the issue and to help provide the base for future funding action.

AREA OF CONCERN TO THE NORTHERN ECOSYSTEM INITIATIVE



For the purpose of the NEI, Northern Canada is defined as the Yukon, Northwest Territories, Nunavut, the Hudson-James Bay lowlands of Ontario and Manitoba, northern Québec and Labrador (Fig. 3). It encompasses a number of ecozones, from the Taiga Shield and Plains, the Southern and Northern Arctic, Boreal Cordillera and the Arctic Cordillera. Each of these zones has specific floral and fauna characteristics and is inhabited to various extents.

4. REGIONAL ISSUES IDENTIFIED IN THE CANADA COUNTRY STUDY REPORT

What follows below is a general summary of potential climate change impacts summarized by the Regional Volumes of the Canada Country Study (CCS) for the different parts of the area of interest to the NEI. Unsurprisingly, the greatest amount of information was found in the Arctic Region chapter. Information from the other regions (Pacific and Yukon, Ontario, Québec and Atlantic) was not as comprehensive, as these reports were more focused on the populated regions of the south. Nevertheless, the chapters were scanned and their findings relevant to the NEI interests are summarized.

Yukon (CCS Volume I)

A number of possible changes have been identified in the Yukon which may have serious ecological impacts. These include: a) An increase of 50 cm in sea level on the north coast of the Territory which will change the coastline and coastal wetlands, b) changes to the frequency and magnitude of flooding and drought events in the region leading to changes in aquatic habitats, c) due to increases in winter precipitation and temperatures, there may be more frequent landslides, permafrost degradation, glacier retreat, d) changes in forest types with northerly movement of the tree line, e) potential extinction of sensitive species, and modification of reproductive capacities of migratory species.

Northwest Territories and Nunavut (CCS Vol II)

In the past 100 years, the Mackenzie District has warmed 1.5°C, the Arctic tundra area by 0.5°, while the Arctic mountains and fjords of the eastern Arctic have cooled slightly. Projections for the future include: In winter, a 5-7°C warming over the mainland and much of Arctic Islands, with a modest cooling in the extreme Eastern Arctic, and increased soil moisture. In summer, a warming of up to 5°C has occurred on the mainland, but only 1-2°C over marine areas. Annual precipitation increases of up to 25 per cent with some early autumn or spring snowfall becoming rain have been measured.

At high latitudes such as in Arctic Canada, glaciers and ice caps seem likely to change little in overall size. Enhanced melting at lower altitudes in summer would likely be combined with increased accumulation in higher zones. A warmer atmosphere and longer thaw period will

be conducive to increased evaporation in the Canadian Arctic. Over land, evaporative losses will be modified according to changes in vegetative cover. Recent work for the Mackenzie Basin suggests that evapotranspiration will increase for that area. Northward flowing rivers throughout the mainland are expected to have decreased flows and levels. The river ice season will be reduced by up to a month by 2050, and up to two weeks for large lakes.

Over half the discontinuous permafrost zone would eventually disappear. The boundary between continuous and discontinuous permafrost will shift northward by hundreds of kilometers although the ultimate position and timing are uncertain. The active layer will deepen slowly in the discontinuous zone to perhaps double its current depth.

Pronounced thermokarst topography and increased erosional effects on coasts are likely. There will be increased frequency of occurrence of shallow landslides. Sea ice occurrence will decline in northern and western areas. There will be a decrease in Northwest Passage winter fast-ice thickness by about 0.5m (although an increased snow cover thickness could temper this) and an increase in the ice-free season of one to three months, are expected. The open water season should lengthen from the current average of 60 days to about 150 days for the Beaufort Sea. The maximum extent of open water in summer will increase from its present range of 150-200km to 500-800km. The maximum thickness of first-year ice will decrease by 50-75%. Decreased first-year ice ridging thickness and old-ice incursion frequency (given no change in the wind regime) are also anticipated.

The potential impacts of these phenomena on natural ecosystems include: a) current global Arctic biomes are expected to change in area as follows: ice - shrink by 12 to 24%, tundra - shrink by 31 to 58%, Taiga/tundra - expand by 16 to 35%. Ecosystem composition will change (more shrubs and moisture tolerant vegetation, less nonvascular plants) and species diversity will decrease. Shrinking of the Arctic tundra biome will occur with a northward shift of the treeline, by up to 750 km in eastern Keewatin. An increase in forest fires, along with more

insects and a longer growing season, is expected to result in noticeable changes in vegetation in the Mackenzie Basin.

b) Insects now common to southern Canada would move into the Mackenzie Basin area. Similarly the pests which are in the region today would move not only further north but also to higher elevations.

C) Terrestrial Wildlife - In the Arctic, the indirect effects of global warming on feed and water availability will be more significant for wildlife. Changes in timing and abundance of forage availability and parasite infestations may accumulate to drive populations into decline with serious consequences for people still depending on them. Bathurst caribou which live north of Great Slave Lake would probably lose weight in part due to heavier snow cover, and in part due to an increase in the number of insects harassing the herd.). North of the mainland, High Arctic Peary caribou and muskoxen may become extinct. Predator-prey relations are a critical component of life cycles of Arctic species; such relations will shift where snow cover and snow type distributions change. The summer habitat of shorebirds in the Mackenzie Delta probably would not change much; on balance, projected future changes in climate and environmental conditions are more likely to be detrimental than beneficial to geese.

d) Freshwater and Marine - Lake temperatures would rise but the effect on fish habitats in freshwater is uncertain. Cold water species might be at greater risk as their potential to adapt is not completely known. Many species in lakes and streams are likely to shift poleward by about 150 km for every 1°C increase in air temperature. The distribution and characteristics of polynyas (ice-free areas, such as the North Water at the northern end of Baffin Island, Hell Gate between Devon and Ellesmere Islands, in Foxe Basin off the coast from Hall Beach, and in Penny Strait) and ice edges that are vital to Arctic marine ecosystems will change. Impacts on mammals such as polar bears, whales and seals, or on seabirds may be both positive and negative, even on the same species. The range and numbers of some Arctic marine mammals, such as beluga and bowhead whales, may increase or at worst hold steady. Ringed and bearded seals, sea lions and walruses require expanses of ice cover for breeding, feeding and other habitat functions and may suffer population decline through pack ice recession. On the other hand, some species (e.g., the sea otter) could benefit by moving into new territories with reduced sea ice. Consequences for polar bears may be especially of concern - prolonging the ice-free period will increase nutritional stress on the Hudson Bay population until they are no longer able to store enough fat to survive. Should the Arctic Ocean become seasonally ice-free for a long period, it is likely that polar bears would become extinct.

Northern Ontario, Hudson Bay lowlands (CCS Vol IV)

This area of large-scale wetland developments has been little studied in terms of potential changes due to a changing climate. Regional water table heights may vary seasonally due to changes in the timing of precipitation and evaporation. This will could lead to changes in greenhouse gas production. Changes to ice conditions in Hudson's Bay could also cause large-scale changes in polar bear wintering areas.

Northern Québec (CCS Vol V)

The Canada Country Study Regional Report identified a number of issues related to Northern Québec and climate change. First is a poor understanding of hydrological variability in a region which is heavily used for hydroelectric generation. This affects fish and waterfowl habitat directly. It may also affect migration pathways of caribou and other wildlife. Climatic factors which affect natural plant and animal populations are also poorly known. This report recommends that critical development stages of important species be studied in terms of sensitivity to climate, especially marine and freshwater fish.

Permafrost in northern Québec is a concern from an ecological standpoint as it is found in large parts of the area and contains unique plant and animal populations. The report contains a recommendation to enhance an existing soil thermal measurement network.

Labrador (CCS Vol VI)

Labrador shares a number of concerns with northern Québec, as the regions are both parts of the Ungava Peninsula. Water resources are exploited for hydroelectric developments which have impacts on freshwater ecosystems. Caribou herds have migration patterns which are determined by climatic variables and the seasonal changes in their ecosystems. Labrador also has a vigorous coastal system which is the home to large coastal bird colonies, seal herds and fish species exploited by society.

5. GOVERNMENT AND UNIVERSITY NORTHERN RESEARCH SURVEY RESULTS

In order to get a better understanding of the ongoing concerns of researchers and of funding agencies, we emailed a survey questionnaire to a wide group of university and government

scientists throughout Canada. We received 71 answers which we then used to determine the scope of present-day work, and the main concerns of active scientists. All individual recommendations from the survey are listed in Appendix B. The survey answers tended to reflect a few major themes which will be summarized below. These are not listed in order of importance, as they are interdependent on each other, and as they touch on a number of themes which are all important in their own right.

a) A first theme is the lack of information on "keystone" or indicator species in the North and how these could be affected by climate. This seems to be the case for freshwater ecosystems, landscape components (soils, flora), or wildlife species. A number of comments also suggest that baseline information on both biotic (e.g., population estimates) and abiotic ecosystem (e.g., temperature, precipitation) are lacking which would provide an accurate baseline of where ecosystems now exist in order to allow for long-term tracking and estimation of changes. Holocene paleolimnological studies might be used to provide some of that information.

b) A second theme which comes out, is the importance of using traditional knowledge in determining what ecosystem components to concentrate on. This has two lines of reasoning. The first is that certain plant and animal populations are critical to the survival of people living in subsistence economies. Second, people living on the land are much more sensitive to, and aware of slight changes to their environment. They can thus provide science a greater insight into better indicators of environmental change.

c) Canada is a very large country. Though parts of the western Arctic are warming, parts of the eastern Arctic have been cooling. It is important to understand and explain these differences in a national context. This also emphasizes that we often cannot make generalizations about climate change the North. Conclusions applying to one part of the region, but not in another can be taken out of context by uninformed or contrary parties, if we have not prepared information to explain what seems to be a discrepancy. This is an important role for climate modelers and climatologists.

d) Fourth, there is a great need to have better access to, or knowledge of, existing and interpreted databases. These include climatological, hydrological, energy inputs, aerial photos, as well as biota surveys. Remote sensing products are not well known to researchers in other fields and should be identified and explained to nonspecialist.

e) Specific interdisciplinary studies were suggested which would improve our understanding of climate-ecosystem interactions in the North, and which did not fall under the broad themes listed above were: fire - forest interactions, terrestrial-aquatic interaction studies, ice-ecosystem interactions.

6. ANALYSIS OF BIBLIOGRAPHIC SEARCH

This bibliography has two main uses. The first was to identify the main topics which have been covered by researchers in the past relating to climate or climate change in the North. The topics have been identified and a short summary of report title content is provided. The bibliography, is not meant to be all-inclusive or exhaustive. It is designed to provide a flavour of what has been done and by whom, which is information needed by the NEI management group in order to determine their research priorities. This means that the interpretation will be biased toward the usefulness of the information from an ecosystem science point of view. It also means that the summaries will not describe the section contents for the specialist of the field being covered. It is not this report's mandate, nor do I feel competent to do stray from fields far from my area of expertise. The second use will be to provide researchers with a starting point when beginning work in a new field. This should provide researchers unfamiliar to the field, a flavour of what has been done and a number of references they can look up.

We purchased a subscription to a bibliographic service provided by the National Information Services Corp. of Baltimore Md. They have assembled a database on Arctic and Antarctic Regions containing almost 800,000 references, both in the refereed and non-refereed literature. This database is updated quarterly from a number of other databases collected from the University of Calgary to the US Library of Congress. We searched the database using the key words climate, climate change, arctic or subarctic and the following secondary words:

atmospheres, coastal, forests, freshwaters and limnology, hydrology, people, soils, wetlands and wildlife.

The methodology followed in this section was to interrogate the most recent NISC Discover™ Arctic and Antarctic Publications database (May 1999) using the key words to extract all possible reports and papers which contained climate and Arctic as key words, from a database of 800,000 references. This means that a large number of papers and reports, which may be relevant to climate and climate change, may not have been included due to the key word issue. The papers extracted were sorted out into categories which are listed below. I tried to remove redundancies in the references as much as possible, but a number of papers will undoubtedly be found more than once. It should also be pointed out that there are a large number of out-of-date reports listed. I have not edited them out as I have no expertise in many of the fields and do not feel qualified to pass judgement on what is or is not relevant outside my field of expertise.

The types of reports which were found include papers from the refereed literature, published books, data reports, technical reports, conference proceedings, and research licence applications. Some attempt was made at controlling the quality of the entries. Most licence applications were removed from the listing, as there was usually no follow-up in the report section. We also felt that the current research survey (other section of this report) took these kinds of studies into account. There were also a number of older conference proceeding abstracts which were never followed up with reports, which were felt not to be sufficiently developed to be included here.

A corollary to the removal of redundancies is that there was sometimes a certain arbitrariness to the assignation of a report to a particular category. There are a number of potential overlaps between categories used which must be acknowledged. For example, the section on Climate Modeling contains a subgroup on the impacts of snow and ice on models. There is also a separate section on snow and ice which contains those reports not directly linked to modeling in their titles. Another example is that paleontological studies are listed in a separate section. However, work on recent samples (e.g., Holocene) would remain with the section of interest (Forestry, Freshwater resources), as they are relevant to the current climate.

After editing, removal of redundancies and of irrelevant results, the bibliographic search produced 1085 references (see Appendix C). There are also a few major sources of information which are either general in nature or are too comprehensive to be listed in the separate

bibliography sections. For example, "The Intergovernmental Panel on Climate Change" has produced a number of very comprehensive reports which often include sections on the North. The following reports are the major outputs of this exercise:

a) IPCC, 1990a. Climate Change: The IPCC Scientific Assessment. J. T. Houghton, G. J. Jenkins and J. J. Ephraums, eds. Cambridge University Press, Cambridge, UK.

b) IPCC, 1990b. Climate Change: The IPCC Impacts Assessment, Cambridge University Press, Cambridge, UK.

c) IPCC, 1992a: Climate Change 1992: The Supplementary Report to the IPCC Scientific Assessment. (J. T. Houghton, B. A. Callander and S. K. Varney, Eds.) Cambridge Univ. Press, Cambridge, U. K.

d) IPCC, 1992b. Climate Change 1992: The Supplementary Report to the IPCC Impacts Assessment, Cambridge University Press, Cambridge, U. K.

e) IPCC, 1994. Climate Change 1994: Radiative Forcing of Climate Change and An Evaluation of the IPCC IS92 Emission Scenarios; Cambridge University Press.

f) IPCC, 1996a. Climate Change 1995. Second Assessment Report on Climate Change, Cambridge Press, 572 pages.

g) IPCC, 1996b. Climate Change 1995: Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analyses. Cambridge University Press, 878 pp.

Similar to the IPCC reports, but more specific to Canada are the reports of the Canada Country Study on Climate Change (summarized above). Published under the auspices of Environment Canada in 1998, results of a national exercise are summarized in a number of reports which have been published by the Canada Country Secretariat, Environment Canada. The summaries can also be found at http://www.ec.gc.ca/ccs.

There are eight volumes in the CCS report. Individual volumes describe known information and identify information gaps for the Atlantic (Vol. VI), Québec (Vol. V), Ontario (Vol. IV), Prairies (Vol. III), the Arctic (Vol. II) and British Columbia-Yukon (Vol. I). There is also a volume (Vol VII) describing sectoral issues (Water Resources, Natural Ecosystems and Biodiversity, Freshwater Wetlands, Agriculture, Fisheries, Forests, Energy, Transportation, Built Environment, Insurance, Health, and Recreation-Tourism. The final volume (Vol. VIII) addresses Cross-Cutting Issues: Economics of Adaptations and Residual Impacts, Extreme Events, Integrated

Assessment of Air Issues, Effects Outside Canada and how this will affect us, Domestic Trade and Commerce, Changing Landscapes, Sustainable Development, and Northern Subsistence and Land-based Economics.

The Mackenzie Basin Impact Study Report was a comprehensive study of that basin, covering a wide range of environmental and socioeconomic issues, including a large number of sections dealing directly or indirectly with climate change. Specific sections are listed within the bibliographic sections of relevance, but the overall summary and references to all the reports are listed in:

> Cohen, S. [Editor] Mackenzie Basin Impact Study (MBIS) : final report. Downsview, Ont.: Environmental Adaptation Research Group, Climate and Atmospheric Research Directorate, 1997.; vii, 372 p. : ill. (some col.), maps (some col.) ; 28 cm.; 0-660-16973-8.).

The summary of the project, along with information on all of its components can be found at the Web site: http://www1.tor.ec.gc.ca/earg/ mbis/ mackenzie.htm. Sections of the report are dedicated to Climate Change. Moreover, a number of other information resources are listed in Appendix A.

7. COMMENTS ON SPECIFIC BIBLIOGRAPHIC SECTIONS

What follows below is a general description of the papers and reports unearthed in the search. As mentioned above, the description is general in nature, it is aimed at ecosystem-climate interactions. It is not aimed at the specialist in the field, though they may nevertheless find literature references useful to them.

Section A: General Climate Predictions and Impacts:

This section mainly contains general papers and reports which describe results of studies or opinions of what climate change may mean in the North. There is also an annotated

bibliography on climate change papers as of 1991 (Handel and Risbey 1992), which is not specifically aimed at the North, but which contains a good starting point for people new to the field of climate change. There are no clear themes running in this, as the section is a collection of papers which are largely nontechnical and aimed at larger audiences.

Section B: Climatology:

The papers in this section provide references to background information which could be used in ecosystem studies. In particular, there are a number of works summarizing or explaining climatic conditions for various regions. Most of these are for the Northwest Territories-Nunavut. There is one recent paper on Labrador (Banfield and Jacobs) and an out-of-date report from Québec (C. Wilson). There are general works which describe northern climatology. There is information on sea-ice distribution and some interpretive climate studies describing the influence of ice, snow, and open waters. Overall, a number of these papers help understand the physical environment in the North and provide useful data which can be used by ecologists.

Section C: Paleoclimates:

Placing today's climate in a longer term context is helped by understanding what has occurred in the past. A number of studies have been undertaken to try to define what past environments were like. These are often done using ice core CO_2 and isotope approaches, as well as using pollen and other indicators. Lake sediment cores have also been used in this. Overall, these studies can be used to place current conditions in a geological context. Studies defining the more recent past, e.g., Late Glacial, Holocene or more recent sediment or ice research has been placed within the sections that best represents them (freshwater, forests, etc...).

Section D: Coastal Systems:

There were few papers which came up in this analysis. Most of these were in relation of shoreline erosion. There is probably more information available on coastal and marine systems in the North and how they relate to climate change, but these did not respond to the key words. Whether or not a few more reports exist is not important in terms of this analysis. What is shown by the few papers we could find, is that little attention has been spent on this topic which could be

of major importance in a world where sea levels may rise measurably. This will be of major interest in much of the North, where the coastline is low-lying.

Section E: People and Society:

Humans are part of the environment and will be affected by a changing climate. The reports we extracted from the database are mostly related to how indigenous people have adapted to the environment in the past. There are a number of historical papers which describe life in pre-development times. There are also a number of papers which are examining how indigenous people are coping with a changing climate. These are mostly in relation to traditional lifestyles, such as hunting of caribou. A number of papers also deal with the relationship of the Inuit with development. There is also a paper on how a changing climate may affect tourism in the North.

In terms of the NEI, these papers emphasize the point that natural resources used in traditional lifestyles will be affected by change in the ecosystem, and thus so will the people. This offers the challenge of ensuring that NEI keeps these close linkages in mind when prioritizing projects for support. Moreover, traditional knowledge will offer a number of interesting interfaces with conventional science which should be taken advantage of.

Section F: Wildlife and General Ecology:

Most of the papers in this section study the interrelationship between various animal groups and climate. For birds, geese, shorebirds, grouse, colonial waterbirds and ducks are studied, mostly in the NW Territories. The same applies to mammals. Dall Sheep, caribou, muskox, marine mammals, porcupines, lemmings and polar bears have been studied. There is also an interesting study on the use of Woolybear caterpillars as indicators of climate (Morewood). There seems to be a paucity of work published from outside of the NW Territories, except for the porcupine work done in northern Québec.

There is more information available which we were not able to raise from the database. With all the major developments done or planned for the North, there is a great deal of information

in environmental impact assessments which could be used in baseline studies or reinterpreted in order to produce some idea of climate-wildlife interactions.

Section G: Freshwater Ecosystems:

There has been a great deal of limnological work in the North, but much of it has been exploratory or specifically aimed at productivity issues. Our survey brought out a low number of papers however. These cover the following topics: general ecology (e.g., Rigler), algal ecology, water chemistry surveys in the NWT and Labrador, paleolimnological studies (e.g., Smol), and a number of fish studies.

We found nothing on the database from northern Québec, even though a large number of papers and reports exist from the James Bay project, which could have direct relevance to climate studies. The same applies to Labrador and northern Manitoba where hydroelectric, as well as other development studies have generated a large amount of both published and unpublished data which are relevant to climate.

Section H: Permafrost, Soils and wetlands:

Most of the papers in this group are on permafrost which is by definition, climate-sensitive. The papers encompass distribution, seasonal dynamics, and controlling factors. There are a number of papers on wetlands for wastewater treatment, and some as habitat. Other papers discuss soil formation in the North. Finally, two papers (Brklavich and Mills) discuss agriculture in the region.

Section I: Greenhouse Gases from Ecosystems:

Most of these papers could fall in the Permafrost/Wetland or Forest sections, but were kept separate as they were quite specific in their orientation. The papers involve quantifying the exchange of CH_4 and CO_2 from soils to the atmosphere. Northern ecosystems are known to be very large stores of greenhouse gases (GHG's). A number of studies have shown that these stores could have a major impact on global GHG cycles, so that it was decided to leave the papers separate for ease of use of the bibliography. Work on GHG's is currently funded by two other agencies within

the Canadian government, the Panel or Energy Research and Development (PERD) or the Climate Change Action Fund (CCAF).

Section J: Vegetation and Forests:

The major themes from these papers are the distribution of vegetation in the North and its relationship to climate and fire. There are also a number of papers which discuss possible changes in the northern forest due to climate change. Fire is also brought up as an important factor in controlling plant distribution and composition as well as the Northern forest's role in global carbon cycling. We also found papers describing timber harvesting issues in the North, nutrient cycling, as well as productivity and energy studies. The distribution papers highlight treeline controls and changes as well as general ecological conditions for plants in the region. Most of the papers are from the NWT, with a few describing conditions in northern Québec.

Section K: Hydrology:

This group was separated into water, ice, and snow papers, as the issues they address are somewhat different.

Water:

There are two main types of papers in this group. There are the reports describing hydrological conditions in the North, and then there are papers which look at how climate will change the hydrology of the region. Northern Canada is a huge area, spanning a variety of climatic and geographic conditions and there is still an important role for exploratory, descriptive studies in the North. A large number of papers have appeared which try to predict how a changing climate will change runoff amounts and timing in the region. There are a few other themes addressed by some papers. A few use isotopic methods to identify sources and routing of water. Others discuss hydroelectric generation issues, as Northern Canada is home to some of the largest hydroelectric projects in the world. It is clear that there is much more information on hydrology, applicable to climate change than was extracted by our survey.

Glaciers, snow and ice:

There are a number of themes which are found in this group of papers. There are some which discuss water or energy balances in glaciers. Other papers discuss remote sensing methods

for quantifying snow and ice coverage in large regions (satellite and radar approaches), or discuss the distribution of cryospheric components. There is a group of papers which discuss how climate change may change glacier, ice and snow formation in the North. Few of these papers relate directly to ecosystems, but may have some relevance to plant and animals studies.

Section L: Climate Modeling:

There are a large number of papers which relate to the development of climate models. These have been separated into General papers, work on Ocean, Sea Ice, snow and glaciers, biological system feedback, and energy balances. Though modeling results will be useful to researchers interested in ecological impacts, most of these papers are focused on helping develop better models. Many probably contain information useful to ecosystem studies, but considering the goals of this scan, will not be described further.

Section M: Atmospheric Chemistry:

A few papers discuss the transport of GHG's in the atmosphere. The main body of papers in this group however, remind us that GHG's are not the only anthropogenically-influenced atmospheric gases which have indirect or direct impacts on ecosystems. Ozone is also an important GHG with other ecological ramifications. A number of papers in the section discuss the chemistry of stratospheric ozone depletion, while a smaller number also addresses ground-level (tropospheric) increases. Another group of papers addresses issues of airborne particles and aerosols, which also have an impact on the estimation of planetary energy budgets, which then complicate the lives of climate modelers. Finally, a group of papers discusses the atmospheric chemistry of micro pollutants.

8. DISCUSSION

Aboriginal People and Climate Change

The CCS Regional Volumes and the results of the literature search and science revealed few published connections between climate change and aboriginal people. Vol VIII, Chapter 8 of the CCS is entitled "Climate Change, northern subsistence and land-based economies", comes to a similar conclusion and makes a number of recommendations regarding information needs. This lack of information could be due to a number of factors. First, climate change is a relatively new field of study, suggesting that a serious analysis of its implications on people living off the land, has not yet been done due to a lack of time. Work should therefore be done, following the CCS recommendations, to better appreciate how aboriginal people could be affected by a changing ecosystem.

Secondly, a major facet of climate change impact research is the analysis of temperature, precipitation, and process trends. Because the field is so relatively new, few quantifiable trends relating aboriginal lifestyles, interactions with wildlife or with other aspects of their environment are available. Finally, the CCS authors make the point that other socioeconomic changes to people living a subsistence existence, are currently very dramatic and acute. It is therefore difficult to identify and separate what the impacts that gradual climate variability could have on them, considering the other major stresses on their lifestyles.

It is clear that aboriginal people will be seriously affected by changes to their environment, as they are so interdependent with it. It is also clear, that the intimate knowledge they have with their surroundings could be of great use to scientist attempting to better appreciate subtle environmental modifications. There is therefore a good opportunity for the scientific (including social sciences) community to work with First Nations groups to identify their main vulnerabilities to a changing environment and to see how traditional knowledge could be combined with the scientific approach to improve our understanding of how northern ecosystems have been changing or could change with time.

Scientific knowledge gaps

Due to its smaller population, and to the higher expenses of conducting science in the North, there is much less specific environmental information for this part of Canada than there is in the southern portion. This makes the analysis of potential or actual climate change impacts more difficult and speculative to do. In order to see how various parts of the ecosystem will change, it is necessary to have baseline data on natural populations and ecosystems. This information is in short supply, and will not necessarily soon be easily available.

The problem is compounded by the fact that not all regions of the Canadian North will be affected in similar ways. For example, the Hudson's Bay region is predicted to get the greatest overall warming in Canada, while on the Labrador coast (though not inland Labrador), annual temperatures will stay cooler. Also, GCM's predict warmer winters most everywhere, thus producing earlier springs and later falls and winters. The North therefore cannot be treated as one homogenous region, with one general rate of warming. The difference in ecosystem types between regions and the issues which are raised, also make a single approach difficult to support. Taking these inhomogeneities into consideration, the question remains as to how the NEI program could make a unique contribution to knowledge of climate change and its impacts in the Canadian North. A number of specific recommendations on ecosystem research have been made by the Regional Volumes of the CCS and these have been listed above. However, there are a number of problems which could be addressed by the NEI to help improve the state of climate change knowledge for the North.

Based on a review of the literature and comments from active researchers surveyed, it is obvious that there is little interaction between environmental and climate scientists. The one major exception to this statement is the hydrological work being done under the GEWEX (Global Water and Energy Experiment) program in the Mackenzie Basin. Getting ecologists and atmospheric scientists to interact would: a) provide much needed information to ecologists about measured trends and climate predictions already available, and b) would make atmospheric modelers aware of specific needs of ecologists to assist them better interpret their data. This type of need is being addressed somewhat by a Climate Change Action Fund (CCAF) grant to the Climate Adaptation Group of the Meteorological Service of Canada (MSC). However, the proposal does not focus on the North, and aims to serve a much larger community than ecosystem

scientists. The NEI could work with the MSC group to enhance knowledge flow for a more specific user group.

APPENDIX A

OTHER RELEVANT PROGRAMS, INITIATIVES and WEB SITES

A number of other groups are interested in climate change in the North and have prepared reports, programs and web sites describing potential impacts and containing recommendations of research needs, or have contributed funding for research. In this section, a number of these groups are listed.

a) The Climate Change Action Fund (http://climatechange.gc.ca/) is a Government of Canada initiative which will distribute $150 million over three years, ending in 2000-2001. Most of the funding is going toward technology research and outreach, but a significant amount is going to fund climate change modeling, impacts and adaptation in the North. The web site identifies which projects have been funded. For example, $145,000 has gone to a Yukon project entitled "Inuit Observations on Climate Change". This list of projects is constantly being revised.

b) The International Arctic Science Committee is composed representatives of circumpolar countries. They have produced a report "Impacts of Global Climate Change in the Arctic Region" which also identifies a number of general recommendations which are similar to the IPCC reports'.

A number of related websites were also uncovered. These are but a small sampling of what is available, but should provide researchers with a place to start.

c) http://www.eelink.net/~asilwildlife/wildlife.html : Wildlife, ecosystems and climate change, produced by the American Society of International Law

d) http://www.ualberta.ca/~ccinst/polar/cci-base.htm: Canadian Circumpolar Institute newsletter Polar Access. Instructions for email subscription to Polar Access are contained on the CCI web site.

e) http://www.pacinst.org/climate.html: Produced by The Pacific Institute for Studies in Development, Environment, and Security. It is an independent, nonprofit center created in 1987 to conduct research and policy analysis in the areas of environment, sustainable development, and

international security. The Institute has three broad goals: to conduct policy-relevant research on the nexus of; international security, environment change, and economic/social development; to collaborate on complementary research efforts with other organizations and individuals; to actively work on developing solutions with policymakers, activists and the general public.

APPENDIX C/ ANNEXE C

NORTHERN ECOSYSTEM INITIATIVE CLIMATE CHANGE BIBLIOGRAPHY

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Appendix B/ Annexe B

Researcher Survey Results/ Résultats du relevé des chercheurs

1 CRYSYS - Use of the Cryosphere for Monitoring Global Change in Canada

KEYS *Glaciers, Ice*

PROJECT OBJECTIVE

To develop capabilities for monitoring and understanding regional and larger-scale variations is cryospheric variables (snow, sea ice, lake ice, glaciers and ice caps, frozen ground, etc. To contribute to the development and validations of local, regional and global models of climate/cryospheric processes and dynamics, and to improve understanding of the role of the cryosphere in the climate system. To Assemble, maintain and analyze key historical, operational and research cryospheric data sets to support climate monitoring and model validation.

GEOGRAPHIC AREA: Resolute/ Churchill, Manitoba/ Central Yukon (Old Crow Flats)/ James Bay, Quebec/ Ellesmere Island/ Fosheim Penninsula/ Canadian High Arctic.
STUDY PERIOD: 1993 to present
PROJECT COST: $ 1,000,000 per year, funded by the Atmospheric Environment Service

PROJECT LEADER: Dr. Barry Goodison, EC/AES/CRB.

COLLABORATORS: Dr. David Barber (University of Manitoba), Dr. Monique Bernier (Universite du Quebec), Mr. Ross Brown (AES), Dr. Melinda Brugman (Columbia Mountains Institute for Applied Ecology), Dr. Margo Burgess (Geological Survey of Canada), Dr. Claude Duguay (Universite Laval), Mr. Bruce Ramsay (Canadian Ice Service, AES), Dr. Mike English (Wilfred Laurier University), Dr. Greg Flato (Atmospheric Environment Service), Dr. Kalifa Goita (University of Moncton at Edmunston), Dr. Roy Koerner (Geological Survey of Canada), Dr. Ellsworth LeDrew (University of Waterloo), Dr. Lawrence Mysak (McGill University), Dr. Terry Pultz (Canada Centre for Remote Sensing), Dr. Martin Sharp (University of Alberta), Ms. Anne Walker (Atmospheric Environment Service), Dr. Ming-ko Woo (McMaster University), Dr. Roger Wheate (University of Northern British Columbia), and Dr. Gordon Young (Wilfred Laurier University).

PROJECT COMMENTS: CRYSYS is an Interdisciplinary Science Investigation in the NASA Earth Observing System Program. Approximately 10 CRYSYS projects are supported each year over a range of geographical locations.

WHAT NEEDS RESEARCH?: 1) Insufficient data for documenting variability and change (Arctic data collection networks are sparse and/or located in non-representative sites): remote sensing offers great potential but data availability and cost are major limiting factors. 2) There is a lack of the required information for validating climate models and climate processes in high latitudes. 3) The climate models used to develop climate change scenarios for the Arctic do not include many of the important processes and feedbacks. 4) Limited incentives for new scientists to train and work in the Arctic - Arctic science is not a high profile activity in Canada, adn Canada's Arctic expertise is thin and waning.

2 **Tree-ring reconstruction of summer temperatures in north-western Canada since 1570 and the relationship to North Pacific atmosphere-ocean variability.**

KEYS *Paleoclimates*

PROJECT OBJECTIVE
To provide evidence that extreme variations in North Pacific atmosphere and ocean conditions affect summer NW Canada regional climate and thus vegetational response.

GEOGRAPHIC AREA:
STUDY PERIOD: Present
PROJECT COST: A-base funded.

PROJECT LEADER: Walter Skinner, Climate Research Branch, Atmospheric Environment Service, Ottawa, Canada.

COLLABORATORS: Barrie Bonsal and Xuebin Zhang, Climate Research Branch, Atmospheric Environment Service.

3 **Climate Change Effects in Watershed Hydrology**

KEYS *Hydrology.*

PROJECT OBJECTIVE
Modelling the impact of climate change on watershed hydrology.

GEOGRAPHIC AREA: North-east Pond river, Newfoundland, Canada
STUDY PERIOD: The study is presently being conducted.
PROJECT COST:

PROJECT LEADER: A. Ghosh Bobba, Environment Canada,NWRI, Burlington, Ontario

COLLABORATORS: Prof. V. P. Singh (Dept. of Civil and Environmental Engineering, Louisiana State Engineering, Baton Rouge, USA), and Prof. L. Bengtsson (Department of Water Resources Engineering, University of Lund, Lund, Sweeden).

RELATED PUBLICATIONS: 1) A. G. Bobba, V. P. Singh, D. S. Jeffries and L. Bengtsson (1997), Application of a watershed runoffmodel to north-east Pond river, Newfoundland: To study water balance and hydrological characteristics owing to atmospheric change, Hydrological Processes, Bo. 11, 1573 - 1593.

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3) A. G. Bobba, V. P. Singh and D. S. Jeffries (1999). Modelling the impact of Climate Change on a Sub-Arctic Watershed in Newfoundland, Canada. NWRI Contribution.

4 **Recent changes at the margin of Barnes Ice Cap, Baffin Island.**

KEYS *Glaciers*

PROJECT OBJECTIVE
Barnes Ice Cap (70 degress N) dominates the hydrology and local climateof the central plateau of Baffin Island. Rapid retreat of the glacier has occurred on the western margin during the 20th Century, in contrast to little or no retreat on the eastern margin. Some 50 years of research make the ice cap and its immediate surroundings an excellent focus for ongoing studies of regional impacts of global climate changes in the eastern Canadian Arctic.

GEOGRAPHIC AREA: Barnes Ice Cap, Baffin Island, Canada.
STUDY PERIOD: 1989 - 1995, 1997, presently not funded.
PROJECT COST: Past funding has totalled approximately $90, 000, from various agencies including NSERC, Environment Canada (AES), NRCan (Polar Continental Shelf Project), The Canadian Space Agency, and the Iqaluit Research Centre.

PROJECT LEADER: Dr. John D. Jacobs, Professor,Dept. of Geography, Memorial University of Newfoundland, St. John's, Newfoundland, A1B 3X9. E-mail: jjacobs@morgan.ucs.mun.ca

COLLABORATORS: Dr. Trevor Bell and Dr. Elizabeth Simms (Memorial University of Newfoundland), Naomi Short (Canada Centre for Remote Sensing).

PROJECT COMMENTS: Building on earlier studies, a program involving automatic weather stations and field surveys was carried out on the ice cap and at the NW margin from 1989 to 1995. A remote sensing and mapping program begun in 1988 with Landsat has been continued with RADARSAT. The latest fieldwork was carried out in 1997 on the eastern margin and included investigations of the glacier margin and the local vegetation, climatology and hydrology.

WHAT NEEDS RESEARCH?: While much of northwestern and central Canada has been experiencing a more-or-less sustained warming over the past century, the eastern Arctic, particularly Baffin Island and West Greenland, have not followed this trend. It is important to monitor events in this region in order to understand the causes and significance of such regional anomalies. Among recommended projects are sustained monitoring of representative glaciers (including mass balance), and quantitative vegetation surveys and mapping in proximity to glaciers.

5 **Integrated Mapping Assessment Project (IMAP): Climate, biodiversity, and land use change in Southern Ontario.**

KEYS *Ecology, Climatology*

PROJECT OBJECTIVE

(1) To develop approaches that can integrate the climate variability and change messages into ecosystem planning and conservation across all relevant decision-making scales.

(2) Identify adaptation options to help conserve existing biodiversity, natural ecosystems and wildlife, using the example of Southern Ontario.

GEOGRAPHIC AREA: Southern Ontario
STUDY PERIOD: present
PROJECT COST: $ 30, 000 O&M, and about $ 30, 000 in-house with resource commitments for more work this fiscal year.

PROJECT LEADER: Don MacIver (AES) and Heather Auld (EC - Ontario Region), 4905 Dufferin Street, Downsview, Ont., M3H 5T4.

COLLABORATORS: BEAK - International Consultants, Brampton, Ont. - Dr. Mark Taylor.

EMAN - Dr. Hague Baughan and Adam Fenech

NRCan, Ontario Ministry of Environment, etc.

6 **Arctic Climate/Permafrost Stations**

KEYS *Permafrost, Climatology*

PROJECT OBJECTIVE

(1) This network of 19 high latitude stations was originally funded by PERD to study possible changes to the permafrost regime in response to climate warming.

(2) The observation program started in 1984; its objective was to collect baseline data for at least 10 years.

(3) Observed parameters vary by site - air temperature profiles were taken at all sites; other parameters may include: humidity, rainfall, total precipitation, snow depth, wind speed and direction, and incoming solar radiation. Observation period varied from hourly to daily.

(4) This data set is useful for modelling permafrost-climate relationships and heat flow in permafrost.

GEOGRAPHIC AREA: A 19 station network was assumed by Atmospheric Environment Service, Climate Research Branch (CRB) in 1995, 9 stations have been decommissioned. The 10 remaining stations are Mayo (2), Kee Scarp, Canyon Creek, Churchill, Hot Weather Creek, Iqaluit (2), Schefferville, and Penny Ice Cap. The decommissioned stations were in Yaya Lake, North Head, Richards Island, Gibson Gap, Yeltea Lake, Blockade Bend, Barnes Ice Cap, Burwash Bay, and Amadjuak Lake.
STUDY PERIOD: 1995 to present
PROJECT COST:

PROJECT LEADER: Paul Y. T. Louie, Climate Processes & Earth Observation Division, Climate Research Branch, Atmospheric Environment Service, 4905 Dufferin Street, Toronto, Ontario, Canada, M3H 5T4. Phone: (416) 739 - 4351. Fax: (416) 739 - 5700. E-mail: Paul.Louie@ec.gc.ca.

COLLABORATORS: Dr. C. Burn (Carleton University), Dr. W. Rouse (McMaster University), Dr. A. Lewkowicz (University of Ottawa), Nunavut Science Centre, Dr. W. Pollard (McGill University), Dr. F. Koerner (GSC).

WHAT NEEDS RESEARCH?: Sparse observation networks; lack of good long-term baseline data sets.

7 **Global climate modelling at the CCCma**

KEYS *Climate Modeling*

PROJECT OBJECTIVE
To develop and apply increasingly sophisitcated numerical models of the global climate system, aimed at improved understanding of the climate systems, and at quantitative projections of future climate change.

GEOGRAPHIC AREA: Canadian Centre for Climate Modelling and Analysis, Victoria, B. C.
STUDY PERIOD: Present
PROJECT COST:

PROJECT LEADER: George Boer and Greg Flato, Canadian Centre for Climate modelling and Analysis, Atmosphe Environment Service, University of Victoria, PO Box 1700, Victoria, B. C., V8W 2Y2.

COLLABORATORS: Other researchers at the CCCma, with wider collaboration via the Climate Research Network (involving numerous Universities).

WHAT NEEDS RESEARCH?: See Marine Science in the Arctic: A Strategy by K. Aagaard et al., Arctic Research Consortium of the United States (ARCUS). Fairbanks, AK, 84pp. Available online at http://www.arcus.org.

8 **The Arctic Ocean and its Role in Climate Change/Climate Variability**

KEYS *Climate Modeling, Oceans*

PROJECT OBJECTIVE
Improved understanding of the role of the Arctic Ocean in climate change and variability; Improved representation of the Arctic Ocean and its ice cover in global climate models.

GEOGRAPHIC AREA: University of Bictoria, CCCma, and Institute of Ocean Science, McGill University.
STUDY PERIOD: Present
PROJECT COST:

PROJECT LEADER: Andrew Weaver, School of Earth and Ocean Science, University of Victoria.

COLLABORATORS: Greg Flato, Ed Carmack, Lawrence Mysak.

WHAT NEEDS RESEARCH?: See Marine Science in the Arctic: A Strategy by K. Aagaard et al., Arctic Research Consortium of the United States (ARCUS). Fairbanks, AK, 84pp. Available online at http://www.arcus.org.

9 **The MacKenzie GEWEX Study (MAGS)**

KEYS *Hydrology*

PROJECT OBJECTIVE

(1) To contribute to the international GEWEX Programme in areas of special Canadian interest and expertise.
(2) To contribute towards the better understanding and prediction of changes to Canada's water resources arising from climatic change.
(3) To understand and model the high latitude water and energy cycles that play roles in the climate system.
(4) To improve our ability to assess the changes to Canada's water resources that arise from climate variability and anthropogenic climate change.

GEOGRAPHIC AREA: MacKenzie Basin, Canada.
STUDY PERIOD: 1992 to present.
PROJECT COST:

PROJECT LEADER: MAGS is an integrated programme of scientific activities in meterorology and hydrology, with many university and government researchers. Head of the GEWEX Management Committee is Dr. Joh Stone, Director-General, Policy, Program and International Affairs, AES, Downsview. Phone: (416) 739 - 4344. E-mail: John.Stone@ec.gc.ca

PROJECT COMMENTS: For more information, see http://www1.tor.gc.ca/GEWEX/MAGS.html

WHAT NEEDS RESEARCH?: There are still major problems concerned with the prediction of temperature, precipitation, river flow, and water resources over northern regions.

10 **Climate Change/Variability Studies Using Paleolimnology Along a Transect of Four NWT-Nunavut National Partks/EMAN-North Sites.**

KEYS *Paleoclimates*

PROJECT OBJECTIVE

This study will contribute to understanding the spatial and temporal distribution of past climate variability and climate change within the Arctic, using a proven palaeolimnological technique of identifying and enumerating various species of freshwater diatom, or other microfossils.

Specifically, the study is designed to:

(1) use proxy data to define past climate variability and climate change over time (i.e. hundreds of years, mostly prior to the keeping of systematic or non-systematic meteorological & climatological records) and space (60 to 82 degress North, 127 to 069 West);

(2) utilize proven techniques of identifying and enumerating varying conditions of temperature, precipitation, and acidic deposition;

(3) build on existing research activities by EC-AHSD Yellowknife receiving 1999/2000FY funding from Parks Canada Agency, Canadian Heritage and Tuktut Nogait NPRs, Burlington, Queens University, and University of Calgary. (....cont'd in Project Comments field...)

GEOGRAPHIC AREA: Nunavut

STUDY PERIOD: Present

PROJECT COST: 1999/2000 FY budget of $2 M for environmental characterization studies and monitoring activities and $ 1 M for O & M expenditures.

PROJECT LEADER: Atmospheric & Hydrologic Sciences Division, Atmospheric Environment Branch, Environment Canada, Yellowknife, NWT, Northern National Parks, Parks Canada Agency, Canadian Heritage, Hull, Quebec.

COLLABORATORS: National Water Research Institute, Burlington, Ontario. Canadian Parks Agency, Canadian Heritage (Nahanni National Park Reserve, Fort Simpson, NWT // Tuktut Nogait & Aulavik National Park Reserves, Inuvik, NWT // Ellesmere Island National Park Reserve, Pangnirtung, NWT). Freshwater Institute, Fisheries & Oceans Canada, Winnipeg, Manitoba. Water Resources Division, Indian & Northern Affairs Canada, Yellowknife, NWT. Polar Continenetal Shelf Project, NRCan, Ottawa, Ontario & Resolute, NWT. Paleoecological Environmental Assessment & Research Lab (PEARL), Pept. of Biology, Queen's University, Kingston, Ontario. Earth Science Program, University of Calgary, Calgary, Alberta. EMAN Co-Ordinating Office, Environment Canada, Burlington, Ontario. Nunavut Research Institute, Inuvik, NWT.

PROJECT COMMENTS: (4) contribute to implementation of the new Tuktut Nogait NPR by Parks Canada Agency, Canadian Heritage.

(5) expand current wildlife and ecosystem studies in Nahanni, Tuktut Nogait, Aulavik, and Ellesmere Island national Parks to include coverage of a broader suite of atmospheric, terrestrial, and aquatic issues, as well as involving local residents in the design and conduct of studies relevant to their interests and needs;

(6) support anticipated new environmental monitoring and research programs currently under development, (...cont'd in Other Comments...)

OTHER COMMENTS: contributions to studies of the Impacts of Climate Change on Northern Ecosystems for the national Northern Ecosystem Initiative (NEI) in NWT and Nunavut, and proposed Nahanni, Tuktut Nogait, Aulavik, and Ellesmere Island National Park activites for the national Ecological Monitoring & Assessment (EMAN) and International Tundra Experiment (ITEX) programs. etc.;

(7) contribute to circumpolar science, in support of Canadian commitments to the Convention on Arctic Flora & Fauna (CAFF), recommended contributions for a Climate Global Observing System (CGOS), and other international scientific commitments; and

(8) encourage and facilitate community involvement in CCAF and Canadian commitment to northern CO2 emission

11 **MacKenzie GEWEX Study Phase II - Development and testing of a cold regions shield hydrological model.**

KEYS *Hydrology*

PROJECT OBJECTIVE

(1) The development of a hydrological model using the information gathered during MAGS 1. This can either be developed as an add on to existin ghydrological models or on its own. It will be coupled to climate models to better simulate the energy and water cycles of the northern shield system.

(2) Testing of the model includes calibration within the location and time period it was derived and validation within other basins and time periods.

GEOGRAPHIC AREA: Canadian Sheild>>MacKenzie Basin
STUDY PERIOD: 2001 - 2005
PROJECT COST:

PROJECT LEADER: Environment Canada. McMaster University, National Water Research Institute. University of Waterloo. Indian and Northern Affairs Canada. Northwest territories Power Corporation. Miramar Con Mine.

PROJECT COMMENTS: At the beginning of MAGS II, a validation field site will be chosen to test the model as it is developed. Field instrumentation will be similar to that from the original field site measuring water an denergy budget components and physiological parameters. A goal is to design the model so that it can operate at varying levels of integration wit other models. The first level of integration will see the model act in isolation. The second level will allow the model to be linked to existing hydrological models. The third level will allow a fully integrated model simulating th energy and water cycles of the entire cold regions sheild climate-hydrological system.

12 **Scenarios for Adaptation: Climate Change and Environmental Health Decision Making in Labrador and Nunavik**

KEYS *People*

PROJECT OBJECTIVE

(1) To collect, summarize, make accessible an disseminate the state of knowledge on climate change and adaptation in the North; through peer involvement and discussion with northern communites, educate local populations on climate change and related public health issues;

(2) To interactively develop informed scenarios for public health and climate change impacts in Nunavik and abrador in order to develop effective response / adaptation strategies;

(3) To build effective partnerships for informed public health, environment and economic decision making support in the North.

GEOGRAPHIC AREA: Nunavik and Labrador.
STUDY PERIOD: Present
PROJECT COST:

PROJECT LEADER: Chris Furgal
Unité de recherche en santé publique
CHUQ-Pavillon CHUL (Centre de santé publique de Québec)
2400, d'Estimauville
Beauport (Québec)
Canada G1E 7G9

COLLABORATORS: (1) Pierre Gosselin: Director, WHO/PAHO Collaborating Research Centre in Environmental and Occupational Health Impacts Assessment and Surveillance, Centre Hospitalier Universitaire de Quebec (CHUQ), Beauport, PQ, G1E 7G9. Tel: (418) 666-7000 ext 468. Fax: (418) 666-2776. E-mail: pgosselin@cspq.qc.ca.
(2) Chris Furgal: Research Associate, Public Health Research Unit, Centre Hospitalier universitaire de Quebec (CHUQ), Beauport, PQ, G1E 7G9. Tel: (418) 666-7000 ext 555. E-mail: CFurgal@cspq.qc.ca.
(3) Francois Boulanger: Environment Canada, Quebec, PQ.
(4) Alain Viau: Professor, Universite Laval.
(5) Labrador Inuit Association and Labrador Inuit Health Commission.
(6) Nunavik Nutrition and Health Committee, Nunavik Regional Board of Health and Social Services.

13 **Effects of water and drought conditions on shorebirds (Problem Identification).**

KEYS *Wildlife, Hydrology*

PROJECT OBJECTIVE

To examine the effects of biotic and abiotic factors (most importantly water conditions and drought) on productivity and survival of prairie breeding shorebirds. Since most shorebirds are dependent on the existence of shallow water foraging habitats, and some species nest on the very edges of wetlands (so flooding is a potential problem), climate change (including drought and flooding) have major implications for productivity of most shorebirds.

GEOGRAPHIC AREA: Southern Alberta
STUDY PERIOD: 1995 to present
PROJECT COST:

PROJECT LEADER: Cheri Trevor-Gratto, Ecological Research Division, Prairie and Northern Region - Environmental Conservation Branch.

PROJECT COMMENTS: Business Line Result: Biological Diversity is Conserved;
Targeted wildlife populations under federal jurisdiction, are sustained at or increased to healthy levels.

14 **Polar Bear Condition, Survival and Reproduction on Hudson Bay (Problem identification).**

KEYS *Wildlife*

PROJECT OBJECTIVE

To monitor the reproductive status and condition of polar bears in western Hudson Bay. In the past 20 years of monitoring the population has remained relatively stable although birth rates, and mean condition of bears in the summer have shown an overall decline. Breakup in western Hudson Bay is about 1.5 weeks earlier on average now than it was 20 years ago and this appears to have shortened the period of time bears can feed before coming ashore to fast. Possible additional effects on seals or other components of the ecosystem are unknown. Cub survival also declined for several years but, more recently, has improved. The reasons for this are not apparent, and thus the monitoring study will continue.

GEOGRAPHIC AREA: Western Hudson Bay, Canada.
STUDY PERIOD: 1991 to 2003.
PROJECT COST:

PROJECT LEADER: Ian Stirling, Northern Conservation Division // Nick Lunn, Northern Conservaton Division.

COLLABORATORS: Government of Manitoba, University of Alberta, NSERC, NWMB, PC.

PROJECT COMMENTS: Business Line Result: Biological Diversity is Conserved; Targeted wildlife populations under federal jurisdiction, are sustanied at or increased to healthy levels.

15 **Effect of Pattern and Timing of Ice Break-up on the Coastal Distribution of Polar bears in western and southern Hudson Bay (Problem Identification).**

KEYS *Wildlife, Sea ice*

PROJECT OBJECTIVE

To determine how the results of all previous aerial, mark-recapture, and satellite radio collar studies may be influenced by the timing and pattern of break-up of sea ice in southern and western Hudson Bay. These will be used to develop co-management agreements in both areas. Aerial surveys of soastal regions of western and southern Hudson Bay have been conducted independently by the Manitoba Department of Natural Resources, Ontario Ministry of Natural Resources, and CWS for about 20 years. Mark-recapture studies and satellite tracking were undertaken to delineate the boundaries of the western and southern Hudson Bay populations.

GEOGRAPHIC AREA: Western and southern Hudson Bay
STUDY PERIOD: 1999-2000
PROJECT COST:

PROJECT LEADER: Ian Stirling, Northern Conservation Division,

COLLABORATORS: Manitoba Department of Natural Resources, University of Alberta, NSERC, NWMB, PC.

PROJECT COMMENTS: Business Line Result: Biological Diversity is Conserved; Targeted wildlife populations under federal jurisdiction, are sustained at or increased to healthy levels.

Impacts of Climate Change on Migratory Birds (Problem Identification)

KEYS *Wildlife*

PROJECT OBJECTIVE
This study investigates the sensitivity of arctic-nesting waterfowl and shorebirds to variations in weather and climate in their breeding, migration-staging and wintering areas. The study will identify species, regions and habitats that may be at risk from global warming.

GEOGRAPHIC AREA: Arctic
STUDY PERIOD: Present
PROJECT COST:

PROJECT LEADER: Hugh Boyd, CWS, Ottawa

COLLABORATORS: AES; National Institute for Ecological Research, Denmark.

PROJECT COMMENTS: Business Line Result: Biological Diversity is Conserved; Targeted wildlife populations under federal jurisdictions, are sustained at or increased to healthy levels.

17 **Report on Trends in Wetlands, Climate and Hydrological Variability (Problem Identification)**

KEYS *Wetlands, Hydrology*

PROJECT OBJECTIVE

To compile long-term data sets on wetland water levels, and to bring these together with other relevant data including climate, land-use, drainage, streamflow and waterfowl numbers. The data sets can then be used in the development of hydrological and ecological models that will contribute to the sustainable management of wetlands under varying climactic and land-use regimes.

Background Info:

Prairie wetlands (commonly known as sloughs) are a major habitat for a wide range of wildlife and are also an important component of the water resources of the region. Water levels in wetlands fluctuate over large ranges in response to climate variability and land use changes.

GEOGRAPHIC AREA: Canadian Prairie Region.
STUDY PERIOD: Present
PROJECT COST: Business Line Result: Biological Diversity is Conserved; Habitat Loss and Fragmentation Trends are Reversed.

PROJECT LEADER: Malcolm Conly, Ecological Research Division.

18 **Carbon Sequestration in Prairie Wetlands and Uplands**

KEYS *Wetlands, Greenhouse gases*

PROJECT OBJECTIVE
In collaboration with NWRI, the Ecological Research Division will be collecting soil samples in and adjacent to wetlands to evaluate the extent of carbon sequestration in wetlands and neighboring uplands. This research will determine the extent to which wetlands mights act as sinks or sources of carbon, as well as assess factors that might act as sinks or sources of carbon, as well as assess factors that might influence carbon dynamics (e.g. frequency of flooding, extent of willow/aspen ring, width of narrative vegetation margin).

GEOGRAPHIC AREA: Canadian Prairie wetlands and uplands.
STUDY PERIOD: Present
PROJECT COST:

PROJECT LEADER: Bob Clarke, Ecological Research Division.

COLLABORATORS: NWRI

PROJECT COMMENTS: Business Line Result: Biological Diversity is Conserved; Habitat Loss and Fragmentation Trends are Reversed.

19 **Conservation of Arctic Flora and Fauna (CAFF)**

KEYS *Ecology*

PROJECT OBJECTIVE
The CAFF program is a forum for scientists, indigenous peoples and conservation managers to address issues of circumpolar concern. Current initiatives include: an overview of the status and trends in key circumpolar species and ecosystems, and assessment of the ecological impacts of climate change and development of a circumpolar approach to monitoring biodiversity in the Arctic.

GEOGRAPHIC AREA: Arctic
STUDY PERIOD: Present
PROJECT COST:

PROJECT LEADER: Kevin McCormick, Northern Conservation Division.

COLLABORATORS: CWS is the lead agency for coordinationg Canada's contribution to this program.

PROJECT COMMENTS: Business Line Result: Biological Diversity is Conserved; The standard of Biodiverstiy conservation is raised in Canada and globally.

PROJECT OBJECTIVE
EMAN-NORTH is a network of ecological monitoring sites and programs that are active in the NWT and Nunavut. The EMAN-NORTH steering committee is composed of representatives from government departments and agencies who are most involved in long-term monitoring in the north. In 1997, th egroup began to focus the NWT program by identifying four broad ecological issues that are of particular relevance to the North, one of which is climate change. Much of the climate change research has been conducted by EMAN-NORTH affiliated moniroing netwroks across the NWT and Nunavut. To date, climate change has been most often measured throught changes in water flows and flood frequency, and through climate records.

GEOGRAPHIC AREA: NWT and Nunavut, Canada.
STUDY PERIOD: 1997 to present.
PROJECT COST:

PROJECT LEADER: Victoria Johnson, Northern Conservation Division

PROJECT COMMENTS: Business Line Result: Human Impacts on the Health of Ecosystems are understood and reduced; Assess and report on the current state and trends of ecosystem health.

21 **Northern Rivers Ecosytem Initiative - Research on Climate and Flow Regime.**

KEYS *Hydrology*

PROJECT OBJECTIVE
To determine the effects of flow regulation, hydrology, and climate on the flow regime of the Peace, Athabasca, and Slave Rivers, enabling the prediction of the potential impacts of climate change on these rivers.

GEOGRAPHIC AREA: Peace River, Athabasca River, Slave River.
STUDY PERIOD: Present
PROJECT COST:

PROJECT LEADER: Frank Letchford, Ecological Research Division.

COLLABORATORS: NREI

PROJECT COMMENTS: Business Line Result: Priority Ecosystems are conserved and restored; Ecosystem Initiatives.

PROJECT OBJECTIVE

An ongoing measurement of breeding performance (timing of nesting, clutch size, hatching, and fledging success) and condition (i.e., indices of parental and chick "quality") of tree swallows is undertaken in response to annual and seasonal variation is weather conditions.

GEOGRAPHIC AREA:
STUDY PERIOD:
PROJECT COST:

PROJECT LEADER: Bob Clarke, Ecological Research Division

23 Wetland Water Levels

KEYS *Hydrology, Wetlands*

PROJECT OBJECTIVE

Ecological Research Division assists in obtaining annual water level readings for all wetlands on St. Denis National Wildlife Area as well as a number of sites at weland complexes located near Swift Current, Saskatoon and Melfort. Much of this wetland monitoring was initiated by the CWS (i.e., Dr. J. Millar) during the 1960's resulting in over thirty years of prairie wetland water level data.

GEOGRAPHIC AREA:
STUDY PERIOD:
PROJECT COST:

PROJECT LEADER: Bob Clarke, Ecological Research Division; Malcolm Conly, Ecological Research Division.

COLLABORATORS: CWS

Winter Ecology of the Hudson Bay Eider in the Belcher Islands, Nunavut

PROJECT OBJECTIVE

Background Information: Hudson Bay Eiders are an economically important species to the community of Sanikiluaq. Eiders spend the winter in open water leads near the Belcher Islands and off the west coast of Quebec. Mass die-offs can occur when these open water leads freeze. This study examines the winter ecology and winter habitat use of the eiders which will provide a better understanding of the frequency, magnitude, and impacts of these die-offs.

GEOGRAPHIC AREA: Belcher Islands, Nunavut, Canada
STUDY PERIOD: 1998-2000
PROJECT COST:

PROJECT LEADER: Grant Gilchrist, Norther Conservation Division; Greg Robertson, CWS Atlantic Region.

COLLABORATORS: NWMB, WHC, WWF, Atlantic Cooperative Wildlife Ecology Research Network, Sanikiluaq, Satellite Imaging Centre of Alaska.

25 **Ecology and Eco-energetics of High-arctic Shorebirds**

KEYS *Wildlife, Coastal*

PROJECT OBJECTIVE

Shorebirds undertake lengthy migrations every year from their breeding grounds in high-arctic Canada to wintering grounds in Europe and the Americas. This study will investigate the energy budgets of shorebirds during their annual cycle. The information will provide an understanding of how and where shorebirds accumulate the energy reserves necessary for their demanding life cycle. It will also help to predict how climate change may affect arctic shorebirds' distributions an dtheir ability to complete their migrations.

GEOGRAPHIC AREA:
STUDY PERIOD: Present
PROJECT COST:

PROJECT LEADER: Guy Morrison, CWS Ottawa.

COLLABORATORS: University of Groningen (The Netherlands), Netherlands Institute for Sea Research, Joint Nature Conservation Committee (U.K.), DND.

26 Population Dynamics of Thick-billed Murres

KEYS *Wildlife, Coastal*

PROJECT OBJECTIVE

Thick-billed Murres are the second most-hunted migratory bird in Canada. Substantial mortality also occurs due to oiling and drowning in gill nets. In addition, aspects of Murre breeding biology (diet, timing of laying, adult mass and chick growth) are affected by environmental conditions. Studying year-to-year changes in Thick-billed Murre ecology helps us to keep track of ongoing changes in local marine ecosystems. This study will increase our knowledge of Thick-billed Murre population dynamics so that more effective management strategies may be formulated.

GEOGRAPHIC AREA: Canada
STUDY PERIOD: 1984 to 2002.
PROJECT COST:

PROJECT LEADER: Tony Gaston, CWS Ottawa.

COLLABORATORS: PCSP, University of Ottawa, Queen's University, NRI, NSTP.

27 Modelling the Thermal Response of Large Northern Lakes to Climate/Climate Change Conditions

KEYS *Hydrology, Energy Balances*

PROJECT OBJECTIVE

To assess potential changes to the cycle of energy exchange and thermal characteristics of large northern lakes. Great Slave lake is used as one example. The general approach is to apply thermal models to simulate potential changes in the thermal structure characterstics for base case climate and GCM derived climate changed scenarios. Preliminary research indicates that large northern lakes (e.g. Great Bear Lake, Great Slave Lake, and Lake Athabasca) may have significant changes in the annual hear storage and thermal characteristics (e.g. Great Bear lake may change from monomictic to dimictic characteristics, etc.). Changes in the thermal characteristics may affect other aquatic ecosyster (biological) components.

GEOGRAPHIC AREA: MacKenzie Basin and Great Slave Lake, Canada.
STUDY PERIOD: FY 2000/01
PROJECT COST: Costs of such a study involves a measurement program to establish meteorological, hydrological an lake thermal variables and model development.

PROJECT LEADER: W. M. Schertzer Ph: (905) 336 - 4770 Fax: (905) 336 - 4989
National Water Research Institute, CCIW william.schertzer@cciw.ca
867 Lakeshore Rd.,
Burlington, Ontario
L7R 4A6

COLLABORATORS: W. R. Rouse, McMaster University

Peter Blanken, University of Colorado (Boulder)

WHAT NEEDS RESEARCH?: The effect of climate change on large norhtern lake physical and ecosystem (biological) responses is poorly understood.

28 **Climate change impacts on lakes, peatlands, and permafrost in NW Canada.**

KEYS *Hydrology, Wetlands, Permafrost*

PROJECT OBJECTIVE
To improve our understanding of, and ability to model, the impacts of climate change on the hydrology of northern Canada, with an emphases on the permafrost regions of NW Canada.

GEOGRAPHIC AREA: Inuvik area, NWT; including ongoing studies in the Mackenzie Delta, and two research basins (one tundra and one boreal forest dominated) located to the east of the Mackenzie Delta.
STUDY PERIOD: present
PROJECT COST:

PROJECT LEADER: Philip Marsh, Environment Canada, NWRI, Saskatoon, Saskatchewan.

COLLABORATORS: Dr. Lance Lesack, Simon Fraser University, Burnaby, BC

Dr. W. Rouse, McMaster university, Hamilton, ON

Dr. J. Pomeroy, NWRI, Saskatoon, SK

WHAT NEEDS RESEARCH?: The study of climate change in northern ecosystems is complicated by the lack of background time series to study how the system has changed, and the lack of appropriate models of the hydrologic system. Detailed understanding of the linkages to the atmosphere and the role of permafrost, show/ice, and unique northern vegetation types greatly limits out ability to model the current system, let alone to model future changes to the system.

29 **Mackenzie GEWEX Project**

KEYS *Hydrology*

PROJECT OBJECTIVE

The long term objectives of the Canadian effort in International GEWEX programme are to (1) understand and model the high-latitude water and energy cycles that play roles in the climate system, and (2) improve our ability to assess the changes to Canada's water resources that arise from climate variability and anthropoogenic climate change. A second phase of investigation is planned to: understand and model the response of energy and water cycles in the Mackenzie basin to climate variability and change, to characterize the impacts of its atmospheric and hydrological processes and feedbacks on the regional and global climatic systems, and to apply our predictive capabilities to climatic, water resource and environmental issues in the Mackenzie basin and other high latitude regions.

GEOGRAPHIC AREA: Mackenzie River Basin region. With research basins located near: Inuvik, and Ft. Simpson, as well as in the Yellowknife River Basin, Wolf Creek, YT; and northern Saskatchewan.
STUDY PERIOD:
PROJECT COST:

PROJECT LEADER: Philip Marsh, Chair, MAGS Science Committee, NWRI, Saskatoon, Saskatchewan.

COLLABORATORS: MAGS is a collaborative project with a large number of both University and Government Scientists. The University groups are funded from a NSERC Network Grant, while the Governmnet groups are funded by NWRI, AES, and the P&N Region of EC. In addition, BC Hydro has provided contributions to the project.

30 **Distributed Hydrological modelling for climate change assessment in Northern Canada**

KEYS *Hydrology*

PROJECT OBJECTIVE
The object of this work is to apply distributed hydrological runoff models in the Northern Basin which are capable of coupling with atmospheric models to assess long-term changes in water resources in Canada's North.

GEOGRAPHIC AREA: **The current focus is on the Mackenzie basin with particular emphases on the Liard, Peace and Athabasca systems.**
STUDY PERIOD: **Present**
PROJECT COST:

PROJECT LEADER: **Dr. A. Pietroniro, National Water Research Institute, 11 Innovation Blvd.**

COLLABORATORS: **E. D. Soulis and N. Kouwen - University of Waterloo.**

T. D. Prouse, P. Marsh - NWRI.

WHAT NEEDS RESEARCH?: **Runoff regime changes and the effect on vulnerable ecosystems, particularly wetland dominated regions.**

31 **Hydro-climatic impacts in the Slave River Delta**

KEYS *Hydrology*

PROJECT OBJECTIVE

In response to the recommendations of the Northern Rivers Basin Study and evalutation is being made of the effects of flow regulation from the Bennett dam, climatic factors and other natural causes on recent changes to the Slave River Delta.

GEOGRAPHIC AREA: Current study on the Slave River Delta and region;
STUDY PERIOD: Present
PROJECT COST: $ 210, 000 over the next three years, funded by NREI, DIAND, and NWRI.

PROJECT LEADER: Dr. Terry D. Prowse, NWRI, Saskatoon.

COLLABORATORS: W. Quinton, NWRI; M. English, WLU; M. Milburn, DIAND.

WHAT NEEDS RESEARCH?: Lack of information about how the hydrologic systems will be altered by climate chagne, especially in the most productive aquatic systems.

32 **Hydro-climatic impacts affecting the Peace-Athabasca catchments and river delta.**

KEYS *Hydrology*

PROJECT OBJECTIVE
This study focusses on defining the relative roles of climatic variability at local (intra-delta) and regional (contributing catchment) scales on this river-delta system. Combining knowledge operating at both scales will permit context suitable for rmaking management decisions about flow regulation operation.

GEOGRAPHIC AREA: Peace River system
STUDY PERIOD: Present
PROJECT COST: $ 245, 000 over the next four years; funded by NREI and NWRI.

PROJECT LEADER: Dr. Terry D. Prowse, NWRI, Saskatoon.

COLLABORATORS: L. Martz, and L. Romolo, U of S and D. Blair, U of W.

WHAT NEEDS RESEARCH?: Lack of information about how the hydrologic systems will be altered by climate change, especially in the most productive aquatic systems.

33 **Climate Change Imacts on Northern River Ecosystems & Adaptation Strategies via the Hydroloelectric Industry**

KEYS *Hydrology, Ice*

PROJECT OBJECTIVE

Employing coupled hydrologic runoff, routing and ice jam models, predict for a range of future climate scenarios the frequency and magnitude of extreme flood events that would inundate the Peace-Athabasca Delta ecosystem. Design a adaptation strategy that can be used by the hydro-electricity industry in their flow operations to mitigate the negative effects of climate change.

GEOGRAPHIC AREA: Conducted on Peace River system.
STUDY PERIOD: Present
PROJECT COST: Funded on an annual basis by PERD, CCAF, and NWRI; approximately $ 250, 000 per year for the next three years.

PROJECT LEADER: Dr. Terry D. Prowse, NWRI, Saskatoon.

COLLABORATORS: A. Pietroniro, P. Marsh, S. Beltaos, NWRI; R. Leconte, Ecole de Technologie Superieure, Montreal; D. Peters, Trent University.

WHAT NEEDS RESEARCH?: Lack of information about how the hydrologic systems will be altered by climate change, especially in the most productive aquatic systems.

34 **Impacts of climate change on the Coppermine River system.**

KEYS *Hydrology*

PROJECT OBJECTIVE
Determine the effect project climate change will have on the flow system of the Coppermine River. A suite of models will be evaluated for their use in northern cold regions environments.

GEOGRAPHIC AREA: Projected two years study of the Coppermine being conducted at NWRI, Burlington and Saskatoon.
STUDY PERIOD: Present
PROJECT COST: Initial funding at approximately $ 60,000/year. Funding by DIAND and NWRI.

PROJECT LEADER: T. D. Prowse and G. Bobba, NWRI, Burlington and Saskatoon.

WHAT NEEDS RESEARCH?: Lack of information about how the hydrologic systems will be altered by climate change, especially in the most productive aquatic systems.

35 **Climate change effects in watershed hydrology**

KEYS *Hydrology*

PROJECT OBJECTIVE
Modelling the impact of climate change on watershed hydrology

GEOGRAPHIC AREA: Applied the watershed runoff model to north-east Pond river, Newfoundland, Canada.
STUDY PERIOD:
PROJECT COST:

PROJECT LEADER: A. Ghosh Bobba, Environment Canada, NWRI, Burlington, Ontario

COLLABORATORS: Prof. V.P. Singh, Department of Civil and Environmental Engineering, Louisiana State University, Baton Rouge, USA.
Prof. L. Bengtsson, Department of Water Resources Engineering, University of Lund, Lund, Sweden.

RELATED PUBLICATIONS: a) A. G. Bobba, V.P. Singh, D.S. Jeffries and L. Bengtsson (1997) Application of a watershed runoff model to north-east Pond river, Newfoundland: To study water balance and hydrological characteristics owing to atmospheric change, Hydrological Processes, Vol. 11, 1573-1593.

b) A. G. Bobba, D.S. Jeffries and V.P. Singh (in press) Sensitivity of Hydrological Variables in the Northeast Pond River Watershed, Newfoundland, Canada, due to Atmospheric Change. Water Resources Management, (18 pages)

c) A. G. Bobba, V.P. Singh and D.S. Jeffries (1999) . Modelling the impact of Climate Change on a Sub-Arctic Watershed in Newfoundland, Canada. NWRI Contribution

Modeling Permafrost Responses to Climate Change in the Mackenzie Basin

KEYS *Permafrost*

PROJECT OBJECTIVE
To develop a regional-scale, physically-based modeling capability to support predictions of the current distribution (occurrence and thickness) of permafrost, and probable changes expected in response to a changing climate.

GEOGRAPHIC AREA: The project focuses on selected regions of interest within the Mackenzie River Valley. Initial investigations were centered on the communities of Fort Simpson and Norman Wells. Our database of climate and terrain information is currently being expanded to include other settlement areas within the Valley
STUDY PERIOD: on-going
PROJECT COST: Current funding levels are in the order of $70K per annum.

PROJECT LEADER: J.F. Wright, Terrain Sciences Division, Geological Survey of Canada, 601 Booth Street, Ottawa ON K1A0E8 Phone:996 9324 Fax: 943 085 e-mail: fwright@gsc.nrcan.gc.ca

COLLABORATORS: Bill Quinton, National Hydrological Research Centre
Rick Lannoville, GNWT Forest Management division
Masood Hussan, GNWT transportation Planning Directorate
M.W. Smith, Carleton University Geography Dept.

WHAT NEEDS RESEARCH?: Major gaps from a permafrost modeling perspective include:

1) lack of reliable information about the distribution of permafrost (critical for calibration and validation of predictive models)

2) lack of reliable information about surface vegetation cover in northern regions

3) lack of information about the distribution and duration of snow cover

37 **The International North Water Polynya Study (NOW)**

KEYS *Marine*

PROJECT OBJECTIVE
To understand the functioning of the North Water, its role in the overall marine Arctic biota and its response to climate change.

GEOGRAPHIC AREA: Field work
(190 days at sea on Canadian Coast Guard ice-breakers supporting 40 scientists) has been carried out in 1997, 1998 and 1999 in the North Water (northern Baffin Bay, between Ellesmere and the Thule Peninsula) and the area is continuously monitored by satellite.

STUDY PERIOD: 1997-2001
PROJECT COST: NSERC core funding of 4.85 millions.

PROJECT LEADER: Louis Fortier,
GIROQ, Department of biology, Universite Laval, Ste-Foy, QUE, Canada G1K 7P4

COLLABORATORS: 60 Principal Investigators from Canada, the USA, Japan, Denmark, Poland, Belgium, the U.K. Canadian collaborators are from 7 Universities, the Departments of Fisheries & Oceans, Environment Canada and National Defence.

WHAT NEEDS RESEARCH?: As far as atmosphere-ocean interactions are concerned, the role of the Arctic ocean in climate regulation in general and, in particular, the nature and role of the newly-identified Arctic Oscillation. Concerning the deep-Arctic basin ecosystem, we know almots nothing of biological production and, hence, carbon cycling in this area.

38 **Climate Change/Variability Studies Using Palaeolimnology Along a Transect of Four NWT-Nunavut National Parks/EMAN-North Sites (CCAF proposal)**

KEYS *Freshwaters, Paleoclimates*

PROJECT OBJECTIVE

This study will contribute to understanding the spatial and temporal distribution of past climate variability and climate change within the Arctic, using a proven palaeolimnological technique of identifying and enumerating various species of freshwater diatom, or other microfossils.

Specifically, the study is designed to:

· use proxy data to define past climate variability and climate change over time (i.e. hundreds of years, mostly prior to the keeping of systematic or non-systematic meteorological & climatological records) and space (60 to 82 degrees North, 127 to 069 West);

· utilize proven techniques of identifying and enumerating various species of freshwater diatoms or other microfossils, which flourish or cease to exist under varying conditions of temperature, precipitation, and acidic deposition;

· build on existing research activities by EC-AHSD Yellowknife receiving 1999/2000FY funding from Parks Canada Agency, Canadian Heritage at Tuktut Nogait and Nahanni NPRs, EC-NWRI Burlington, Queens University, and University of Calgary;

· contribute to implementation of the new Tuktut Nogait NPR by Parks Canada Agency, Canadian Heritage, including a 1999/2000FY budget of $2M for environmental characterization studies and monitoring activities and $1M for capital and O&M expenditures;

· expand current wildlife and ecosystem studies in Nahanni, Tuktut Nogait, Aulavik, & Ellesmere Island National Parks to include coverage of a broader suite of atmospheric, terrestrial, and aquatic issues, as well as involving local residents in the design and conduct of studies relevant to their interests and needs;

· support anticipated new environmental monitoring and research programs currently under development, contributions to studies of the Impacts of Climate Change on Northern Ecosystems for the national Northern Ecosystem Initiative (NEI) in NWT and Nunavut, and proposed Nahanni, Tuktut Nogait, Aulavik and Ellesmere Island National Park activities for the national Ecological Monitoring & Assessment (EMAN) and International Tundra Experiment (ITEX) programs, etc.;

· contribute to circumpolar science, in support of Canadian commitments to the Convention on Arctic Flora & Fauna (CAFF), recommended contributions for a Climate Global Observing System (CGOS), and other international scientific commitments; and

· encourage and facilitate community involvement in CCAF and Canadian commitment to northern CO2 emission reduction and related measures, as part of Canada's response to the Kyoto Protocol.

GEOGRAPHIC AREA:
STUDY PERIOD:
PROJECT COST:

PROJECT LEADER: Douglas HalliwellNorthern SectionAtmospheric & Hydrologic Sciences DivisionAtmospheric Environment BranchEnvironment Canada301, 5024-50th AvenueYellowknife, NT X1A 1E2Tele: (867) 6609-4741 Fax: (867) 873-8185Email: doug.halliwell@ec.gc.ca

COLLABORATORS: Mr. Douglas HalliwellNorthern SectionAtmospheric & Hydrologic Sciences DivisionAtmospheric Environment BranchEnvironment Canada301, 5024-50th AvenueYellowknife, NT X1A 1E2Tele: (867) 6609-4741 Fax: (867) 873-8185Email: doug.halliwell@ec.gc.ca Dr. Derek MuirLimnologyCanada Centre for Inland WatersNational Eater Research InstituteEnvironment Canada867 Lakeshore Road, P.O. Box 5050Burlington, ON L7R 4A6Tele: (905) 319-6421 Fax: (905) 336-6430Email: derek.muir@odin.cciw.ca
Mr. Bruce RigbyNunavut Field Unit, Canadian Parks ServiceCanadian Heritage4th Floor, 25 Eddy StreetHull, PQ K1A OM5Tele: (819) 997-4935 Fax: (819) 994-5131Email: Bruce_Rigby@pch.gc.ca Dr..Lyle LockhartFreshwater Institute, University of ManitobaFisheries & Oceans Canada501 University CrescentWinnipeg, MN R3T 2N6Tele:

39 **Effect of climate change on permafrost geomorphology and hydrology**

KEYS *Permafrost, Hydrology*

PROJECT OBJECTIVE
To assess the potential impacts of climate change on earth surface processes in permafrost regions. Particular attention is placed on slow and rapid mass movements (landslides) and on runoff generation. Methods used include field monitoring and experimentation in the field and the laboratory.

GEOGRAPHIC AREA: Fosheim Peninsula, Ellesmere Island. New project just starting in south-west Yukon and western Arctic.

STUDY PERIOD: Past 10 years
PROJECT COST:

PROJECT LEADER: Professor Antoni Lewkowicz, Department of Geography, University of Ottawa, Ottawa, Ontario K1N 6N5, alewkowi@uottawa.ca

COLLABORATORS: Professor Peter Johnson at same address

WHAT NEEDS RESEARCH?: Lack of understanding of basic processes which could have ecological impacts. Thus prediction of the effects of climate change is difficult or impossible. e.g. our recent work has shown that salts present in permafrost may be released by climate change with consequent surface salinization. This conclusion arose from a study that did not focus on climate change but on the current slope hydrology and geochemistry.

40 **Étude de l'affaiblissement au réchauffement des propriétés mécaniques du pergélisol sensible aux changements climatiques**

KEYS *Permafrost*

PROJECT OBJECTIVE
Prédire l'impact des changements climatiques sur le pergélisol en tant que fondation naturelle des infrastructures civiles nordiques et du paysage nordique

GEOGRAPHIC AREA: Umiujaq (Québec nordique) 56° 33' N, 76° 33' W

STUDY PERIOD: Période 1998-2001 avec plusieurs travaux de terrain à Umiujaq (20 heures/mois en moyenne)
PROJECT COST:

PROJECT LEADER: Richard Fortier, Ph. D., ing.
Professeur adjoint
Département de géologie et de génie géologique
Membre-chercheur
Centre d'études nordiques
Université Laval
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G1K 7P4
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Adresse électronique: richard.fortier@ggl.ulaval.ca

COLLABORATORS: Sylvie Buteau, étudiante au doctorat
Michel Allard, Membre-chercheur du Centre d'études nordiques
Yves Michaud, Chercheur scientifique à la Commission géologique du Canada

WHAT NEEDS RESEARCH?: Nous n'avons aucune idée de l'évolution des infrastructures civiles et du paysage nordique établies sur du pergélisol riche en glace s'il y a fonte partielle ou complète du pergélisol en cas de réchauffement climatique majeur.

41 Inuvialuit knowledge and Climate Change, Banks Island, NWT: Using Inuvialuit environmental knowledge to complement western science

KEYS ~~People~~

PROJECT OBJECTIVE

The project is a graduate research project that is exploring how Inuvialuit traditional environmental knowledge can contribute to current scientific understandings of climate change and its potential impacts on the Western Arctic. The research asks - Can local experts on the land contribute to the formulation of scientific hypotheses, thus participating in a meaningful and complementary way in Arctic climate change research?

GEOGRAPHIC AREA: The project is being undertaken with the community of Sachs Harbour, Banks Island, NWT.
STUDY PERIOD: It is currently underway and will conclude in the fall of 2000. The budget for is approximately $25 000.
PROJECT COST: $25K

PROJECT LEADER: Dyanna Riedlinger, MNRM Candidate, Natural Resources Institute, University of Manitoba, R3T 2N2
Dr. Fikret Berkes (advisor), Natural Resources Institute, University of Manitoba, R3T 2N2

COLLABORATORS: The community of Sachs Harbour, Banks Island, NWT
International Institute for Sustainable Development (pursuing a larger project involving the production of a video showing climate change through the eyes of Inuit and explaining it according to traditional knowledge).

WHAT NEEDS RESEARCH?: Much of our current knowledge of climate change in the North is based on scientific findings, largely confined to modeling, climatology and biology. Since field research in the North is costly and often seasonally limited, this almost exclusive focus has limited our understandings of climate change and its potential impacts on northern ecosystems and communities.
Climate change research provides a rich setting for the study of the dynamic relationship between humans and the environment. A study of this relationship, as expressed through the medium of traditional environmental knowledge, can be used to complement, and in some cases enhance, science-based understandings of climate change on land and people.

KEYS *Soils*

PROJECT OBJECTIVE

1. To apportion sediment accretion on coastal Gleysolic soils to,firstly the rate of crustal rebound and secondly future increase of water levels due to melting of permafrost.
2. To complete a technical memorandum on the soils of the Lowlands

GEOGRAPHIC AREA: This work is being done at the University of Guelph using samples collected on about 10 sampling trips between 1972 and 1991 with the bulk of sampling in the 1976 to 1980 period. I have published papers but still have additional data on the accretion rates to publish.

STUDY PERIOD:

PROJECT COST:

PROJECT LEADER: Leader: Dr Richard Protz
Land Resource Science
University of Guelph
Guelph Ontario
N1G 2W1
T 519 824 4210 ext 2481
F 519 824 5730
rprotz@lrs@uoguelph.ca

COLLABORATORS: Dr AJ Vandenbygaart
Dr C Duke

WHAT NEEDS RESEARCH?: Short Comings: The lack of systematic studies with precise landscape control so that changes as measured by data from precise High Resolution Satellites would be creditable.

43 **Stability of permafrost slopes in a warming climate**
Objective:

KEYS *Permafrost*

PROJECT OBJECTIVE
Determine the likelihood of slope failures in ice-rich terrain during individual warm years or longer-term increases in air temperature. Carry this out by improving the understanding of frozen and thawing ground mechanics, dating landslides, and correlating occurrence with instrument measurements or climate reconstructions.

GEOGRAPHIC AREA: Mackenzie River Valley,
STUDY PERIOD: 1999-2000
PROJECT COST: $30,000

PROJECT LEADER: Larry Dyke, Geological Survey of Canada, 601 Booth St. Ottawa, Ontario K1A 0E8

COLLABORATORS: Aboriginal Land and Water Boards in jurisdictions including the Mackenzie River, University of Ottawa

WHAT NEEDS RESEARCH?: Given that forest fires are one of the most effective triggering agents for landslides, lack of understanding of the relationship between forest fire occurrence and climate change.

44 **Impacts of Holocene climatic change and environmental stress on aquatic ecosystems**

KEYS *Freshwaters, paleoclimates*

PROJECT OBJECTIVE

A multidisciplinary paleolimnological approach is used to provide detailed insights into the amplitude and variability of environmental conditions and the response of northern freshwater ecosystems to Holocene climatic and environmental change.

GEOGRAPHIC AREA: Northern Québec and Labrador, with focus on treeline region
STUDY PERIOD: from 1994 until 2003
PROJECT COST: 23,000/year

PROJECT LEADER: Reinhard PIENITZ
Centre d'études nordiques & Dept. of Geography
Laval University
Québec (Québec)
G1K 7P4, Canada

COLLABORATORS: - Dr. Ian Walker (Okanagan University College, Kelowna)
- Dr. Konrad Gajewski (Ottawa University, Ottawa)

WHAT NEEDS RESEARCH?: Lack of basic understanding of interactions between atmospheric, terrestrial and aquatic environments (e.g. terrestrial-aquatic linkages).

45 **Aquatic microbial foodwebs and responses to global change**

KEYS *Freshwaters*

PROJECT OBJECTIVE

This ongoing, long term program is focused on how the physical environment (UVR, PAR, temperature and hydrodynamic processes) influence community structure and processes at the base of foodwebs in lakes, rivers and the coastal sea. Our primary study sites are at high latitude (subarctic Canada, the circumpolar High Arctic and Antarctica) where the physical environment is currently subject to rapid change.

GEOGRAPHIC AREA:
STUDY PERIOD:
PROJECT COST: NSERC individual grant to WFV : 64,450 per annum
Plus equipment

PROJECT LEADER: Warwick F. Vincent
Département de biologie & Centre d'études nordiques
Université Laval, Sainte-Foy QC G1K7P4
Email: warwick.vincent@bio.ulaval.ca

Response of microbial foodwebs in northern lakes and rivers to global change

KEYS *Freshwaters*

PROJECT OBJECTIVE

Logistic support for the Canadian High Arctic component of Project1, from Polar Continental Shelf Project. Addional logistic support is provided by Centre d'études nordiques (e.g., the research station on Hudson Bay)

GEOGRAPHIC AREA:

STUDY PERIOD:

PROJECT COST: PCSP logistics to WFV : 25,000 per annum

PROJECT LEADER: Warwick F. Vincent
Département de biologie & Centre d'études nordiques
Université Laval, Sainte-Foy QC G1K7P4
Email: warwick.vincent@bio.ulaval.ca

47 **Évolution des lacs nordiques face aux changements climatiques et aux perturbations naturelles et anthropiques**

KEYS *Freshwaters*

PROJECT OBJECTIVE

This program combines paleolimnological, paleoecological and limnological techniques to place the current changes northern lakes within the context of their historical variability. A major component of this work is on the bio-optical and paleo-optical characteristics of northern lakes, with emphasis on how these properties change in response to climate and to variations in catchment-lake interactions

GEOGRAPHIC AREA:

STUDY PERIOD:

PROJECT COST: FCAR: Team grant; 23,500 per annum to WFV and Reinhard Pienitz
Plus equipment (currently under review for renewal)

PROJECT LEADER: Warwick F. Vincent
Département de biologie & Centre d'études nordiques
Université Laval, Sainte-Foy QC G1K7P4
Email: warwick.vincent@bio.ulaval.ca

48 **Bio-optical characterization of northern lakes with MERIS: A contribution towards understanding the impact of climate change on freshwater ecosystems in Canada.**

KEYS *Freshwaters*

PROJECT OBJECTIVE

Provision of images from the satellite ENVISAT. The aim is to develop novel optical indices that can be used in the long term monitoring of global change from space. The work is focused on our south-north transect of lakes in eastern North America from latitudes 44 to 82 oN.

GEOGRAPHIC AREA:

STUDY PERIOD:

PROJECT COST: European Space Agency, imagery to WFV (program leader), R. Pienitz and C. Duguay : equivalent to $255,000 per annum

PROJECT LEADER: Warwick F. Vincent
Département de biologie & Centre d'études nordiques
Université Laval, Sainte-Foy QC G1K7P4
Email: warwick.vincent@bio.ulaval.ca

PROJECT OBJECTIVE

This work is based on our south-north transect of lakes to examine the distribution of contaminants in northern lake waters and sediments.

This is part of our ensemble of 'global change' programs, but may be outside the scope of your compilation

GEOGRAPHIC AREA:

STUDY PERIOD:

PROJECT COST: TSRI : : ? per annum

PROJECT LEADER: Warwick F. Vincent

Département de biologie & Centre d'études nordiques

Université Laval, Sainte-Foy QC G1K7P4

Email: warwick.vincent@bio.ulaval.ca

COLLABORATORS: Derek Muir (Environment Canada, Leader) et al.

High Arctic lake ice and ice shelf dynamics as barometers of climate change

KEYS *Glaciers*

PROJECT OBJECTIVE

This project will evaluate the use of two ice features of Ellesmere Island in the Canadian High Arctic as indicators of change: the Ward Hunt Ice Shelf (lat. 83N) and the ice cover of Lake Hazen (lat. 81 N).

GEOGRAPHIC AREA:
STUDY PERIOD:
PROJECT COST: $28 242 requested from the the Climate Change Action Fund

PROJECT LEADER: Warwick F. Vincent
Département de biologie & Centre d'études nordiques
Université Laval, Sainte-Foy QC G1K7P4
Email: warwick.vincent@bio.ulaval.ca

COLLABORATORS: R Pienitz and C. Duguay :

Interactions trophiques et dynamique de population de la grande oie des neiges

KEYS *Wildlife*

PROJECT OBJECTIVE

Étude à long terme de la dynamique de populations de la grande oie des neiges nichant à l'Ile Bylot, Nunavut
· Études des interactions trophiques (plantes-herbivores et herbivore-prédateur) à l'Île Bylot.
o Réponse à court et à long terme des plantes et des milieux humides au broutement par les oies et aux variations dans les conditions abiotiques.
o Relations entre les principaux prédateurs terrestres (renards, goélands, labbes et harfangs) et leurs proies principales (oies et lemmings).

GEOGRAPHIC AREA: Projet à long-terme se déroulant à l'Île Bylot, Nunavut,
STUDY PERIOD: Depuis 1989
PROJECT COST:

PROJECT LEADER: Gilles Gauthier
Département de biologie et Centre d'études nordiques
Université Laval
SteFoy, Qc, G1K 7P4
Tel: 418-656-5507
FAX: 418-656-2043
e-mail: Gilles.Gauthier@bio.ulaval.ca

COLLABORATORS: Line Rochefort, département de phytologie et Centre d'études nordiques, Université Laval
Michel Allard, département de géographie et Centre d'études nordiques, Université Laval
Jean-François Giroux, département de sciences biologiques, Université du Québec à Montréal
Austin Reed, Service canadien de la Faune, Environnement Canada, Ste-Foy, Qc
Esther Lévesque, département de chimie-biologie, Université du Québec à Trois-Rivières

WHAT NEEDS RESEARCH?: · Absence de base de données à long-terme
· Manque d'étude sur les processus (par opposition à des études descriptives).
· Peu d'études expérimentales
· Manque d'études multidisciplinaires
· Peu d'études intégrant les composantes abiotiques (eau, sol, glace) et biotiques (microorganismes, végétation, faune

KEYS *Paleoclimates*

PROJECT OBJECTIVE
Objective: Reconstruction of paleoenvironments in the CAA from last glacial maximum to today, including glacier ice cover, sea level (coastline)
position, summer sea ice cover, distribution of marine mollusc zones, and
distribution of major marine mammals.

GEOGRAPHIC AREA: Field work throughout the CAA
STUDY PERIOD: 1999-2004
PROJECT COST: about 50 k$/year (NRCan) plus about 40
k$/year NSERC (through collaborators)

PROJECT LEADER: Arthur S. Dyke, Geological Survey of Canada, 601 Booth Street,
Ottawa, ON K1A 0E8

COLLABORATORS: Dr John England, Earth and Atmospheric Sciences, U Alberta;
Dr James Savelle, Anthropology, McGill University, Montreal

WHAT NEEDS RESEARCH?: Shortcomings: Regional structure and driving mechanisms of past climate changes, faunal and human responses to climate changes, temporal resolution of past climate changes.

53 **Assessing the impact of climate variation and change on latitudinal clines for non-anadromous and anadromous Arctic char (Salvelinus alpinus) populations in Canada**

KEYS *Freshwaters*

PROJECT OBJECTIVE

Investigate present-day geographic variation in critical life-history parameters of anadromous and non-anadromous Arctic char (e.g., growth, fecundity), and establish the significance of climate induced variations in the freshwater environment and the marine environment which may impact these populations.

Work consists primarily of a compilation of data from the relevant literature covering the North American distribution of Arctic char. 1999/00 is the final year of a three year project funded by the Ocean Climate Programme of Fisheries and Oceans Canada. Application has been made for continuation of funding.

GEOGRAPHIC AREA:
STUDY PERIOD: ongoing
PROJECT COST:

PROJECT LEADER: J. Reist, Scientist and project contact, Dept. of Fisheries and Oceans, Central and Arctic Region, 501 University Crescent, Winnipeg, MB, R3T 2N6, Telephone:(204) 983-5032, Fax: (204) 984-2403, E-mail: reistj@mpo-dfo.gc.ca.

COLLABORATORS: M. Power, Visiting Scientist, Central and Arctic Region and Associate Professor, University of Manitoba, Winnipeg, MB, R3T 2N2, Telephone (204) 474-9655, Fax: (204) 261-7251, E-mail: power@cc.umanitoba.ca.
G. Power, Professor, University of Waterloo, Waterloo, ON, N2L 3G1, Telephone: (519) 885-1211 extension 2568, Fax: (519)-885-0534.
J. B. Dempson, Scientist, Dept. of Fisheries and Oceans, Newfoundland Region, P.O. Box 5667,St. John's, NF, A1C 5X1 Telephone: 709-772-4475, Fax: 709-772-3578, E-mail: dempson@athena.nwafc.nf.ca..

WHAT NEEDS RESEARCH?: Lack of understanding of impacts at the level of the aquatic ecosystem (e.g., temperature shifts, loss of critical thermal habitat, changes in flow regime, invasion of thermally tolerant taxa), and how these will translate into impacts on the biota in the systems. Anadromous fish such as char are particularly important from this perspective given that they will be affected by changes in both freshwater and marine areas.
· Second order shifts in ecosystem structure and function resulting from major changes elsewhere – e.g., higher temperatures result in greater ice free season in marine environments such as the Beaufort Sea, which results in greater mixing of waters, which results in disruption of nearshore brackish water layers but higher marine productivity, which would suggest that higher productivity of anadromous fish would result but this would be offset by disruption in the feeding environment due to brackish water disruption.
· Climate change is viewed as a major potential impact on biota, ecosystems and people especially in the north, but it is only one of several large as well as local impacts (e.g., contaminants, habitat changes, fisheries). Climate change as part of a cumulative impacts scenario needs consideration.

54 **Permafrost response to recent climate warming in the Mackenzie Delta and Yukon Coas**

KEYS *Permafrost*

PROJECT OBJECTIVE

To investigate the response of permafrost in coastal areas to recent climate warming, including an unusually warm year in 1998. Documentation of natural slope failures (thaw slumps) and detailed measurements of ice wedges are compared to similar observations taken in previous years/decades. Measurements of thaw depths are compared to previous measurements taken by the Geological Survey of Canada throughout the Mackenzie valley

GEOGRAPHIC AREA: Investigations were undertaken during July 1999 in the Mackenzie
> Delta and Yukon Coast will thaw depth monitoring is ongoing.
STUDY PERIOD:
PROJECT COST:

PROJECT LEADER: Stephen Wolfe
Geological Survey of Canada
601 Booth St.
Ottawa, ON, K1A 0E8
ph. 613-992-7670
FAX 613-992-0190 Email: swolfe@gsc.nrcan.gc.ca

Scott Dallimore, Mark Nixon

55 **The Labrador Ashkui Project - Linking Science and Innu Knowledge to understand spatial and temporal patterns and ecological characteristics of spring open water areas in Labrador**

KEYS *Freshwaters, Ecology*

PROJECT OBJECTIVE

Ashkui, spring open water areas, have been identified by the Innu a areas of critical importance to their traditional way of life. These areas act as concentrators for wildlife and fish, provide traditional medicines and have importance from a social and cultural perspective. This project uses traditional knowledge and scientific to:

a) Document the spatial and temporal patterns of Ashkui
b) Characterize the ecological function of specific Ashkui
c) Develop a model of landscape classification based on culturally significant landscape units.

The project entails remote sensing and GIS applications to track the spatial distribution and temporal patterns of Ashkui. This work is a collaborative effort between Environment Canada, the Innu Nation, the Canada Center for Remote sensing and most recently the Canada Ice Center. Data aquisition, image purchase and interpretation, ground truthing and GIS analysis represent a commitment of approximately 150K per annum.

The site research component has just been initiated and involved chemical, phytoplankton and bacterial characterization of ten selected ashkui. Wildlife and fish abundance research is planned for the next field season. Annual costs for this work are estimated at approximately 65K per annum.

Traditional knowledge interviews with Innu elders have been conducted and the oral history work is the interpretation phase. This work is being conducted by the Gorsebrook Institute of St. Mary's University. Annual costs for this work are approximately 40K.

GEOGRAPHIC AREA: The research area covers most of Labrador with specific sites located on a southeast to northwest transect centered at the north end of Grand Lake. Research focuses on the spring period from April to June to span initial formation of the Ashkui to total open water condition.

STUDY PERIOD:

PROJECT COST:

PROJECT LEADER: Geoff Howell / Dave Wilson
Ecosystem Science Division
Environmental Conservation Branch
Environment Canada
45 Alderney Drive
Dartmouth Nova Scotia

COLLABORATORS: Environment Canada
Canada Center for Remote Sensing
Canada Ice Center
Innu Nation
St Mary's University
Dalhousie University
Institute for Environmental Monitoring and Research
Memorial University
Hyperspectral Data Incorporated

56 **Remote sensing of glacier ice margin.**

KEYS *Glaciers*

PROJECT OBJECTIVE
Detect and monitor glacier ice margin location and characteristics using multispectral and radar imagery (unfunded).

GEOGRAPHIC AREA:
STUDY PERIOD:
PROJECT COST:

PROJECT LEADER: Élizabeth L. Simms
Department of Geography, Memorial University of Newfoundland

COLLABORATORS: J. Jacobs, A. Simms.

WHAT NEEDS RESEARCH?: Knowledge shortcomings: Sharing quality field data to calibrate remote sensing data that, including aerial photographs, have been available for at least the last 40 years.

57 **Niche Axes of Newfoundland Marine Fishes (incl. Labrador)**

KEYS *Marine*

PROJECT OBJECTIVE

To characterise the temperature and depth niche axes for common marine fishes, and to use this information to traace the niche space occupied over time. Question is: is it shrinking or expanding?

GEOGRAPHIC AREA:

STUDY PERIOD:

PROJECT COST: This is an important and on-going research focus here, supported mainly by NSERC funds. Amount varies per year.

PROJECT LEADER: Richard L. Haedrich
4 Clark Place/NICOS
Memorial University
St. John's, Newfoundland A1B 5S7 Canada
tel: (709) 737-8833
fax: (709) 737-3121
e-mail: haedrich@morgan.ucs.mun.ca

COLLABORATORS: a number of people, including especially Dr. Johanne Fischer, EuroGOOS Office, UK and Dr. Larry Hamilton, Univ New Hampshire, USA. Plus, of course, graduate students.

WHAT NEEDS RESEARCH?: rate of change and impacts on community structure, including human societies.

58 **Labrador geomorphology, particularly fluvial and coastal landforms in the Churchill R-Lake Melville area.**

KEYS *Hydrology*

PROJECT OBJECTIVE
To quantitatively assess these landforms and examine the impacts of climate change/variability and anthropogenic impacts (e.g. dam construction/operation)

GEOGRAPHIC AREA: Labrador
STUDY PERIOD:
PROJECT COST:

PROJECT LEADER: Norm Catto
Department of Geography
Memorial University of Newfoundland
St. John's, NF, A1B 3X9
Canada

Tel: (709) 737-8413 or 737-7417
FAX: (709) 737-3119

WHAT NEEDS RESEARCH?: The linkages between climate change/variability and landforms are poorly known almost everywhere.

PROJECT OBJECTIVE

NCD is a partner for this new centre for climate change for Northern Canada, located at Yukon College. NCD developed the methodology for and leads the analysis of the state of knowledge and the priority-setting exercise for climate change impacts and adaptations that will be carried out through the NCEC.

GEOGRAPHIC AREA:

STUDY PERIOD:

PROJECT COST: Recently-funded CCAF project.

PROJECT LEADER: contact Joan Eamer, EC, P & N region

60 Impact of Climate Change on Migratory Caribou

KEYS *Wildlife*

PROJECT OBJECTIVE

Herd-specific assessments and application of tools to evaluate public policy options. This research project is led by NCD and extends across northern North America.

GEOGRAPHIC AREA:
STUDY PERIOD:
PROJECT COST: Recently-funded CCAF project.

PROJECT LEADER: contact Joan Eamer, EC, P & N region

61 Arctic Borderlands Ecological Knowledge Co-op

KEYS *Ecology*

PROJECT OBJECTIVE

NCD co-ordinates the Co-op. Participants are co-management bodies, First Nation and Inuvialuit organizations, government agencies and university researchers. Activities include monitoring, data synthesis, and communications. Science-based and local knowledge are used. Climate change is a key focus of the Co-op NCD maintains the web site at http://www.taiga.net/coopThis is an EMAN site.

GEOGRAPHIC AREA:
STUDY PERIOD:
PROJECT COST: In 5th year of operation and expanding. Recently became a non-profit organization.

PROJECT LEADER: contact Joan Eamer, EC, P & N region

KEYS *Hydrology, vegetation, ecology*

PROJECT OBJECTIVE

NCD works with NWRI (Saskatoon) and DIAND (Yukon) to co-ordinate this large ecological research basin. Studies focus on climate and its relationships with hydrology, energy flows, snow ecology, permafrost, and vegetation. NCD also carries out research and monitoring in the Basin. NCD maintains the web site at http://www.taiga.net/wolfcreekThis is an EMAN site.

GEOGRAPHIC AREA:

STUDY PERIOD:

PROJECT COST: Funding and support on a project-by-project basis, with no formal, funded coordination.

PROJECT LEADER: contact Joan Eamer, EC, P & N region

63 **Sustainability of Arctic Communities under Global Change**

KEYS *Wildlife, Societies*

PROJECT OBJECTIVE

NCD staff are responsible for caribou energetics and population modeling, and for the Internet-based "Possible Futures" model and communications in this U.S. National Science Foundation project (which involves 3 Canadian communities). The project looks at a range of indicators of ecosystem and community sustainability in relation to climate change, oil development, and tourism. Phase 1 results are being prepared for publication in various journals and on the web site athttp://www.taiga.net/sustain(developed and maintained by NCD).

GEOGRAPHIC AREA:

STUDY PERIOD:

PROJECT COST: A three-year Phase 2 of the project is under consideration by NSF for funding.

PROJECT LEADER:

KEYS *Wetlands, Permafrost*

PROJECT OBJECTIVE

NCD, in partnership with Laval University, is conducting a retrospective analysis of changes in water cover of the Old Crow Flats, a Ramsar site (wetland of international significance). Satellite imagery is being used to track changes in this permafrost-melt landscape. Residents of the aboriginal community of Old Crow have told scientists that the wetlands are drying up due to the changing climate. This Northern Ecosystem Initiative demonstration project is developing methodology that can be applied to other extensive northern wetlands. Satellite images are being analysed and methodology developed (this is the first year of this two-year project).

GEOGRAPHIC AREA:
STUDY PERIOD:
PROJECT COST:

PROJECT LEADER:

65 **Climatology of High Arctic Oases**

KEYS *Climatology, Vegetation*

PROJECT OBJECTIVE

The purpose of this study is to determine the climatic characteristics of these lush vegetated areas in comparison to the surrounding polar desert. The study was initiated in 1980 as part of the ecosystem study at Alexandra Fiord on Ellesmere Island, which was completed in 1984. The work has been continued in order to obtain a longer-term database. Two other sites have since been added: Polar Bear Pass on Bathurst Island and Truelove Lowland on Devon Island. The focus of the study apart from the climatic aspects focuses on relating the surface energy budget to the synoptic climatology.

GEOGRAPHIC AREA:

STUDY PERIOD:

PROJECT COST: The major cost of this project was the acquisition of an automatic monitoring station, which was approximately $9,000.00. The yearly costs have been for maintenance (~ 300.00 per year) and travel and personnel costs for the yearly visit, station servicing and data management and analysis. These costs are approximately $ 3,500.00 per year.

PROJECT LEADER: The principal investigator is Claude Labine presently on leave from Campbell Scientific Canad 11564 149 Street, Edmonton, Alberta, T5M 1W7 but presently working in the Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta.

Climatology of High Arctic Ice Caps.

KEYS *Climatology, Glaciers*

PROJECT OBJECTIVE

The purpose of this research is to determine the climatology of an ice cap. Up to now, there have been no climate data for the ice cap except for what is interpreted from the mass balance and ice core data from the site. This study is allowing us to understand in greater detail the annual temperature regime of the ice cap as well as the precipitation pattern.

GEOGRAPHIC AREA: The work was initiated in 1988 on the Agassiz Ice Cap, Ellesmere Island.

STUDY PERIOD:

PROJECT COST: The major cost of this project was the acquisition of an automatic monitoring station, which was approximately $9,000.00. The yearly costs have been for maintenance (~ 300.00 per year) and travel and personnel costs for the yearly visit, station servicing and data management and analysis. These costs are approximately $ 3,500.00 per year.

PROJECT LEADER: Dr. R. Koerner of the Glaciology Section, Terrain Sciences Division, Geological Survey of Canada in Ottawa, Bea Alt of Balanced Environment Associates in Ottawa and Claude Labine of Campbell Scientific Canada in Edmonton.

PROJECT OBJECTIVE

This purpose of this research is to determine the climatology and meteorology within the Ellesmere Island Park. The applications for this work are varied: basic climatological background, climate variability within the park, climate change, and human impact assessment.

GEOGRAPHIC AREA:

STUDY PERIOD: The work was initiated in 1988 with the establishment of two automatic stations, one at Tanquary Fiord, the second near Lake Hazen. Since then two other stations have been established, one at Ward Hunt Island and the other at Fort Conger on the east coast of Ellesmere.

PROJECT COST: The major cost of this project was the acquisition of the automatic monitoring stations, which were approximately $10,000.00 each. The yearly costs have been for maintenance (~ 300.00 per year) and travel and personnel costs for the yearly visit, station servicing and data management and analysis. These costs are approximatel $ 3,500.00 per year.

PROJECT LEADER:

This work is a collaboration between Parks Canada, Ellesmere Island Park, Pangnirtung, Nunavut and Claude Labine of Campbell Scientific Canada of Edmonton.

WHAT NEEDS RESEARCH?: The most important shortcomings regarding climate change in northern ecosystems are:

- quality of existing net radiation data and the need to evaluate and correct this parameter
- the lack of sound and long term measurements of the surface energy budget of the main surfaces of the Arctic Islanc
- the lack of long-wave incoming radiation measurements
- the need for a better coverage of monitoring sites especially away from coastal areas.

68 **Paleolimnological Assessments of Long-Term Environmental Change**

KEYS *Paleoclimates, Freshwater*

PROJECT OBJECTIVE
We are surveying large suites of lakes throughout the Canadian High Arctic, Sub-Arctic, as well as other regions (e.g. Siberia, Alaska, etc) to determine the present-day limnology and diatom assemblages in these lakes. We then use paleolimnological techniques to reconstruct past environmental and climatic changes, and attempt to determine if these changes were related to natural causes, or were the result of anthropogenic activities

GEOGRAPHIC AREA: Each summer, we typically work on a new island in the Canadian High Arctic, and sample typically 40 or so lakes. In addition, we have students working in other arctic regions.
STUDY PERIOD: JPS has been working in the High Arctic since 1983; MSVD since 1986
PROJECT COST: Most of JPS's NSERC grant ($115,500/yr) and MSVD's grant ($23,000) is spent on arctic work. In addition, we get generous PCSP support, typically worth about $20,000/yr each (helicopter. Twin Otter, etc). Also, other small grants at ca. $10,000 a year. Finally, we have some 'in kind' support from Derek Muir (CCIW) for water chemistry analyses.

PROJECT LEADER: John P. Smol
Paleoecological Environmental Assessment and Research Lab (PEARL)
Dept. Biology, 116 Barrie St.
Queen's University
Kingston, Ontario K7L 3N6 Canada
Phone: (613) 533-6147
FAX: (613) 533-6617
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COLLABORATORS: Marianne S.V. Douglas
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22 Russell St.
University of Toronto
Toronto, Ontario
M5S 3B1, Canada
Tel: (416) 978-3709
Fax: (416) 978-3938
Email: msvd@opal.geology.utoronto.ca

Many graduate students; also Derek Muir (CCIW)

69 The Cultural Landscape of Labrador: Linking Aboriginal and Scientific Knowledge of the Environment.

KEYS *People, Societies*

PROJECT OBJECTIVE
Identify means and methods for creating a hybrid ecological knowledge base for Labrador.
Identify and describe the landscape of Labrador from an Innu perspective.
Build science based research into an understanding of the Innu Landscape
Find original ways to communicate ecological knowledge between peoples.
Develop working partnership between Innu Nation, Environment Canada and Gorsebrook research Institute
Case study on Ashkui (areas of early open water) completed in 1998
Determine spatial and temporal overlap of Ashkui with Low Level Flying Activities in Labrador

GEOGRAPHIC AREA: Southern and Central Labrador
STUDY PERIOD: on-going
PROJECT COST: Gorsebrook Research Institute 1999-2000 commitment to Ashkui related projects: approx. 50K

PROJECT LEADER: Christopher Fletcher, Assistant Executive Director/Research Officer, Gorsebrook Research Institute, Saint Mary's University, Halifax, NS B3H 3C3. Phone: 902-420-5523, email: christopher.fletcher@stmarys.ca

COLLABORATORS: Geoff Howell, Environment Canada (Dartmouth NS) Ecosystems Science Division.
Larry Innes, Innu Nation Environmental Advisor.

WHAT NEEDS RESEARCH?: Aboriginal knowledge of - and perspectives on - ecosystems generally, effects of climate change on Aboriginal lifeways, absence of baseline on which change can be judged for many Northern areas, regional variations in Northeastern Canada, effects on staging areas of migratory birds, interaction of climate change impacts with industrial developments in North, cumulative impacts.-

70 **Seabird demography and marine environmental variability at the Gannet Islands, Labrador**

KEYS *Ecology, Wildlife*

PROJECT OBJECTIVE
To quantify the response of populations of marine birds and their prey (fishes and invertebrates) to environmental variability (e.g., variation sea water temperature and nutrient content), including climate change.

GEOGRAPHIC AREA: Gannet Islands, coastal Labrador (53.98N 56.69W)

STUDY PERIOD: Long term study (began 1996). Fieldwork takes place May-September
PROJECT COST:

PROJECT LEADER: Dr. Ian L. Jones, Biology,
Atlantic Cooperative Wildlife Ecology Research Network
Department of Biology, Memorial University of Newfoundland
St. John's, Newfoundland, A1B 3X9 Canada

COLLABORATORS: Canadian Wildlife Service, Environment Canada
Dept,. of Tourism, Culture and Recreation, Government of Newfoundland and Labrador

71 **Long-term changes in marine bird ecology in northern Hudson Bay and Hudson Strait**

KEYS *Ecology, Wildlife*

PROJECT OBJECTIVE

Monitor changes in timing of breeding, reproductive success, recruitment and survival and changes in the diets of adult and nestling marine birds in northern Hudson Bay and Hudson Strait. Diet changes are linked to changes in marine foodwebs and the dynamics of ice break-up through observations of foraging behaviour.

GEOGRAPHIC AREA: Coats Island and Digges Island
STUDY PERIOD: on-going
PROJECT COST: about 50K annually (includes PCSP support, but not PYs - including PYs, about 150K).

PROJECT LEADER: Anthony J. Gaston, Canadian Wildlife Service, National Wildlife Research Centre, 100 Gamelin Blvd., Hull Quebec K1A 0H3

COLLABORATORS: Grant Gilchrist, Canadian Wildlife Service, Yellowknife

WHAT NEEDS RESEARCH?: Understanding the response to climate change of keystone species within Arctic food webs

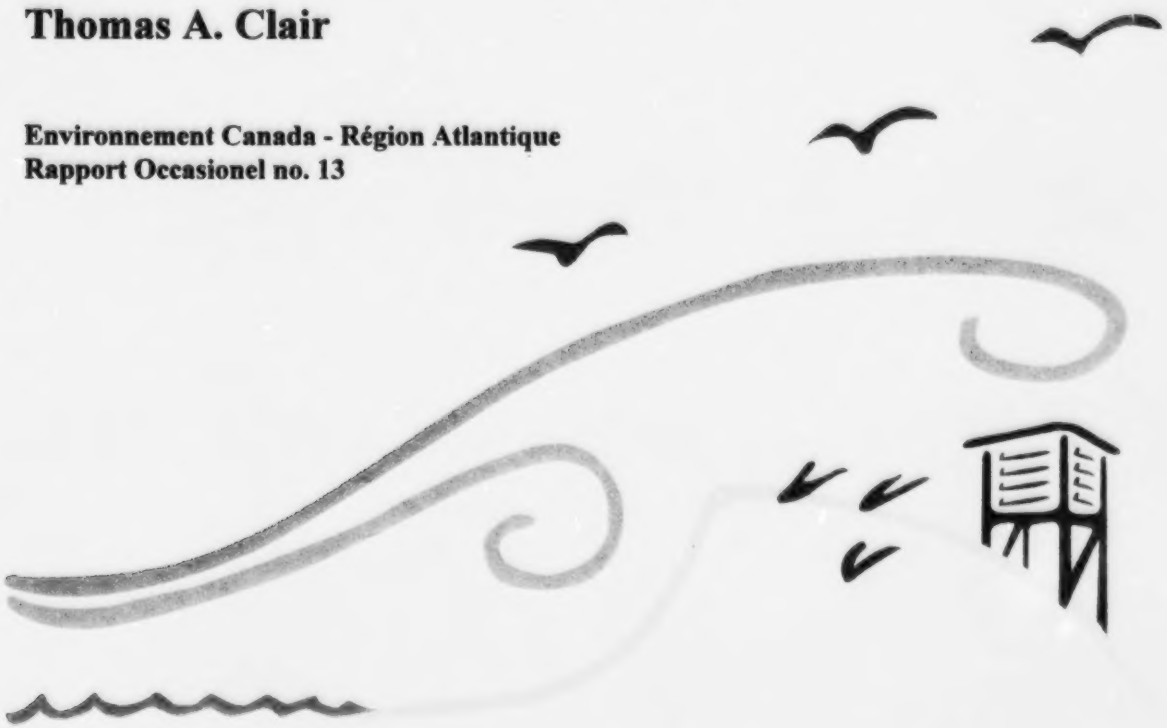
Environment Canada Environnement Canada

Recherches sur les changements climatiques et les écosystèmes dans le Nord canadien

Rapport présenté à l'Équipe de gestion de l'Initiative portant sur les écosystèmes nordiques

Thomas A. Clair

Environnement Canada - Région Atlantique
Rapport Occasionel no. 13



Autres rapports dans la série:

Numéro du rapport occasionel:

1. **Atlantic Maritime Ecozone Research and Monitoring, Workshop Proceedings, March 1993.**
2. **Ecological Monitoring and Research at Kejimkujik National Park, 1978-1992.**
3. **Kejimkujik Watershed Studies: Monitoring and Research Five Years after "Kejimkujik '88".**
4. **Ecological Monitoring and Research in the Coastal Environment of the Atlantic Maritime Ecozone, Workshop Proceedings Huntsman Marine Laboratory, March 9-11, 1994.**
5. **Ecological Monitoring and Research in Atlantic Canada: A Focus on Agricultural Impacts in Prince Edward Island.**
6. **Science and Policy Implications of Atmospheric Issues in Atlantic Canada, Workshop Proceedings Halifax, N.S., November 28-30, 1995.**
7. **Canada Goose Studies in the Maritime Provinces 1950-1992, Compiled by Anthony Erskine, January 1997.**
8. **Bay of Fundy Issues: a scientific overview, Proceedings of a Workshop, Wolfville, N.S., January 29 to February 1, 1996. (mars 1997).**
9. **Climate Change and Climate Variability in Atlantic Canada, Proceedings of a Workshop, Halifax, N.S., Dec. 3 to 6, 1996. (mars 1997).**
10. **Trends of Acid Precipitation Chemistry Variables in some Atlantic Canada National Parks. (avril 1997).**
11. **Using Environmental Prediction in Ecosystem Science in Atlantic Canada, Workshop Proceedings, Halifax, N.S. (mars 1998).**
12. **Understanding Change in the Bay of Fundy Ecosystem. Workshop Proceedings, Sackville NB (avril 1999).**

Recherches sur les changements climatiques et les écosystèmes dans le Nord canadien: Rapport présenté à l'Équipe de gestion de l'Initiative portant sur les écosystèmes nordiques

Préparé par :
Thomas Clair, Ph.D.
Direction de la conservation de l'environnement
Environnement Canada – Région de l'Atlantique
Sackville (N.-B.)
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Environment Canada
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Région de l'Atlantique

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RÉSUMÉ GÉNÉRAL

La direction de l'Initiative portant sur les écosystèmes nordiques (IEN) a commandé un document faisant la synthèse des renseignements qui existent au sujet des changements climatiques et des écosystèmes dans le Nord. L'objectif de ce document est de déterminer quelles recherches ont été menées à ce sujet jusqu'à aujourd'hui et quels sont les principaux besoins en la matière. Fort de ces informations, ce rapport contient des recommandations à l'intention de la direction de l'IEN sur la façon d'apporter une contribution exceptionnelle et utile en vue d'améliorer les connaissances sur le sujet.

L'auteur s'est acquitté de cette mission en plusieurs étapes. Il a commencé par résumer les informations au sujet des changements récents survenus dans le climat du Nord et de ce que prédisent les modèles de circulation générale actuels pour la région. Il a ensuite analysé à la loupe l'Étude pan-canadienne (EPC) (1998) pour se faire une idée des recherches récentes menées sur le climat dans le Nord. Il a également résumé les recommandations régionales émanant de l'EPC qui font état des carences locales au niveau des connaissances.

Il a ensuite adressé un questionnaire aux chercheurs du gouvernement et du milieu universitaire pour leur demander ce qu'ils faisaient sur le chapitre des écosystèmes et des changements climatiques dans le Nord. Les répondants ont été priés de préciser les lacunes existantes au niveau des données et des informations. Soixante et onze réponses ont été reçues, analysées et leur liste figure à l'annexe B. Enfin, il a analysé en profondeur la documentation pour connaître les paramètres que les chercheurs ont étudiés sur les changements climatiques dans le Nord par le passé. Il a ainsi recensé plus d'un millier de rapports et d'articles qui sont classés par catégories à l'annexe C. Une section du présent rapport résume également brièvement la teneur de chaque titre.

Ce rapport formule un certain nombre de recommandations à l'intention des gestionnaires de l'IEN, selon ces démarches. Les recommandations sont assez générales et ne visent pas des questions locales ou précises, car celles-ci ont déjà été abordées dans les tomes de l'EPC consacrés aux régions et qu'il en est rendu compte ci-après. Ces recommandations ont pour but d'établir des liens entre diverses spécialités du savoir et intérêts qui seraient

autrement impossibles.

Le premier objectif des recommandations est de permettre à l'IEN de fournir aux écologues, aux environnementalistes et aux spécialistes des sciences sociales, de même qu'aux populations autochtones, un résumé des conditions climatiques qui règnent dans le Nord, ainsi qu'une analyse de ce que prévoient les modèles climatiques. Cela contribuera à sensibiliser les groupes d'intérêt à ce problème et leur permettra de concevoir des études et d'interpréter les données sur le climat, les changements climatiques et les écosystèmes de manière plus intelligente. Le deuxième objectif est de faciliter les recherches sur les écosystèmes en regroupant les chercheurs sur le climat, les éléments climatiques ou la climatologie au sein d'équipes de conception ou d'étude. La troisième recommandation porte sur l'incorporation des connaissances ancestrales ou des préoccupations des Autochtones dans le choix des projets.

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RECOMMANDATIONS À L'INTENTION DES GESTIONNAIRES DE L'IEN

Si l'on se fonde sur les renseignements glanés dans le questionnaire rempli par les chercheurs sur le Nord, sur les recherches bibliographiques et les parties pertinentes de l'Étude pan-canadienne (EPC), on peut formuler un certain nombre de recommandations à l'intention des gestionnaires de l'IEN. La liste ci-après propose des activités précises qui ne font pas double emploi avec ce que font d'autres chercheurs. Les recommandations ont pour but d'offrir des outils aux scientifiques et autres étudiants des écosystèmes nordiques pour leur permettre de mieux comprendre les conditions climatiques actuelles et futures.

Recommandations spécifiques :

a) Il est clair d'après l'analyse bibliographique que plus de recherches ont été faites sur l'atmosphère et l'hydrologie que sur l'écologie. Il est également clair, toutefois, que les recherches sur la modélisation climatique, la climatologie et l'hydrologie sont mal connues du milieu des écologues. L'IEN doit donc organiser de toute urgence un forum pour initier les membres du milieu des écologues et des Premières nations aux plus récents résultats des recherches sur la modélisation climatique, la climatologie et l'hydrologie, et leur permettre d'interroger les modélisateurs au sujet de ces résultats. Cela produira un certain nombre d'éléments. Premièrement, les éventuels usagers des données comprendront mieux les hypothèses inhérentes à l'établissement de ces modèles et pourront donc les utiliser à bon escient. Cela permettra également aux usagers de formuler des remarques sur les rapports possibles entre les projections climatiques et leur sphère d'intérêt. Cela permettra par ailleurs aux modélisateurs d'élargir l'utilisation de leurs produits. Cette recommandation doit être étudiée parallèlement au Fonds d'action pour le changement climatique qui déploie actuellement des efforts à cet égard.

b) Un autre grand besoin recensé et qui pourrait être bénéfique pour un grand nombre d'usagers a trait à l'amélioration de l'interprétation des bases de données climatologiques et hydrologiques se rapportant au Nord. Ces données constituent le

fondement de nombreuses recherches sur les écosystèmes du Nord et d'ailleurs. Compte tenu de la rareté géographique des données dans cette sphère d'intérêt, il faut rendre ce qui existe plus convivial et facile d'accès aux chercheurs sur les écosystèmes. En particulier, l'IEN doit commander un rapport décrivant le climat actuel et prévu de la région. Le cadre de référence d'un tel rapport devra être préparé conjointement par un climatologue et un écologue pour que les éventuels usagers de ces données puissent préciser leurs besoins.

c) Les populations autochtones du Nord vivent en harmonie étroite avec la terre. Les variations qui caractérisent les modes de migration de la sauvagine ou des grands mammifères et les changements qui se produisent dans l'état des glaces et les eaux charriées par les rivières ont des conséquences directes sur leur existence. D'après les recherches déjà menées par l'EPC, on sait qu'il est important de collaborer avec eux, peut-être dans le cadre d'ateliers, afin de cerner les éléments écosystémiques qui revêtent de l'importance pour leur vie et de déterminer leur degré de sensibilité aux changements climatiques. Il faut également savoir qu'il y aura sans doute de gros écarts régionaux au niveau des répercussions possibles. Leur proximité de certains indicateurs écologiques devrait aider les scientifiques à savoir ce qui présente le plus d'intérêt pour les études traditionnelles des tendances écologiques.

d) En prenant ce document comme point de départ, il faut amorcer un dialogue avec les autres organismes gouvernementaux qui font des recherches sur les changements climatiques. Mentionnons notamment le Fonds d'action pour le changement climatique (FACC), le Service météorologique du Canada, le ministère des Affaires indiennes et du Nord, Pêches et Océans Canada, le Conseil national de recherches en sciences naturelles et en génie du Canada, le Northern Climate Exchange au Yukon College, ainsi que d'autres gouvernements territoriaux et provinciaux. Il faut également consulter des ONG comme certaines associations autochtones et des groupes d'universitaires.

INTRODUCTION

Le Nord du Canada est une vaste région qui chevauche un certain nombre d'écozones et qui subit l'influence de plusieurs régimes climatiques. Bien que les climats soient dynamiques et en perpétuelle évolution, il semble que la température dans le Nord du Canada augmente depuis plusieurs dizaines d'années (figure 1). Les hausses les plus draconiennes sont survenues l'hiver dans le bassin du Mackenzie, tandis que les températures hivernales ont chuté dans les régions de l'Ungava et du Labrador. L'est de l'Arctique affiche un réchauffement des températures nettement moindre l'hiver, ce qui peut ou non revêtir de l'importance. Les changements climatiques au printemps suivent les mêmes courbes que l'hiver, encore que moins intensément, et sont minimes l'été et l'automne.

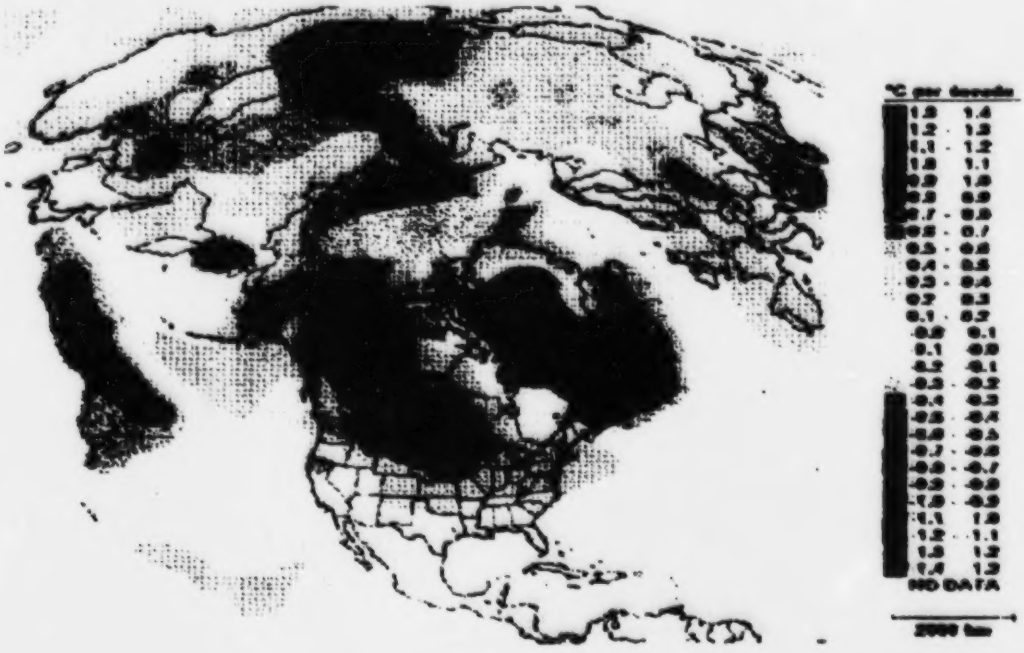

Figure 1 Changements de température en Amerique du Nord 1960-91. Information du Centre climatologique Hadley, Grande-Bretagne

Personne ne s'entend actuellement sur la cause exacte du phénomène en vertu duquel la température augmente dans une région et diminue dans une autre. Il est clair, toutefois, que la dynamique climatique est complexe dans le Nord du Canada et que cette complexité est accentuée par l'immense superficie de la région. Les résultats récents des modèles de circulation générale prédisent également d'importantes variations des températures dans le Nord du Canada (figure 2). Tout porte à croire que la température dans cette région augmentera plus vite que dans le reste du continent, même si certaines parties du littoral du Labrador n'afficheront pas de gros écarts. Même si la figure 2 fournit une estimation annuelle moyenne, les prévisions saisonnières perpétuent la tendance observée jusqu'ici d'hivers et de printemps plus chauds par rapport à l'été et à l'automne. Cela indique donc que le printemps débutera plus tôt et l'hiver plus tard que ce n'est actuellement le cas dans le Nord.

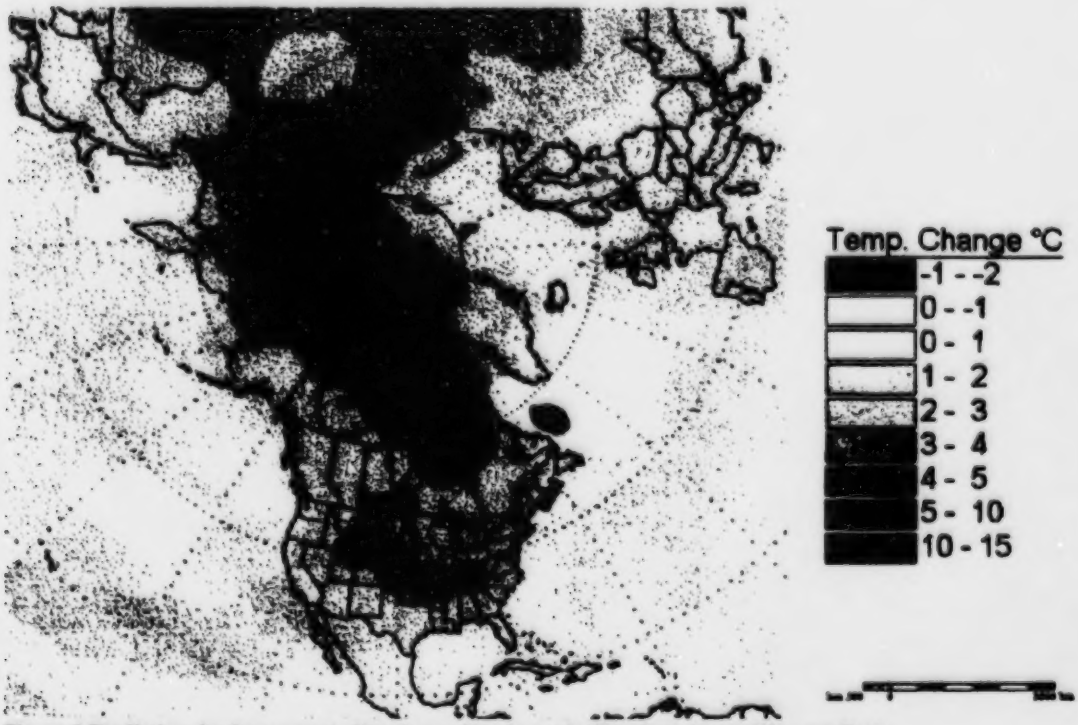

Figure 2 Prediction de changement climatiques dans le nord. (Résultats du modèle canadien).

Ces variations des températures (ainsi que des précipitations) auront-elles des effets mesurables sur les écosystèmes? Compte tenu de la complexité des régimes climatiques, comme l'attestent les différences entre l'est et l'Ouest de l'Arctique, il est clair que l'on peut faire certaines généralisations sur les effets écologiques pour l'ensemble du Canada, même si un certain nombre de conditions régionales entrent également en jeu. Dans ce rapport, nous cherchons à aborder cette question selon la méthodologie suivante. Premièrement, nous entendons résumer les sensibilités régionales aux changements climatiques de même que les principales données manquantes et les recommandations des recherches qui figurent dans l'Étude pan-canadienne (EPC), sans oublier d'autres sources que nous avons consultées durant la préparation de ce rapport.

Deuxièmement, nous résumons les résultats d'un questionnaire envoyé à des experts scientifiques pour déterminer les recherches qui se font actuellement et ce qui, à leur avis, constitue d'importantes lacunes au niveau des données. Troisièmement, nous procédons à une analyse des publications environnementales sur les changements climatiques. Ces données permettent de déterminer sur quels éléments les recherches scientifiques ont notamment porté par le passé et quels éléments ont été le moins étudiés et méritent donc une analyse plus fouillée.

Sur la base des renseignements glanés ci-dessus, ce rapport fournit deux types de résultats. Dans un premier temps, il permet de recenser les lacunes de notre somme de connaissances au sujet des processus écologiques et du climat dans le Nord. Dans un deuxième temps, il formule des recommandations à l'intention des gestionnaires de l'IEN pour les types de recherches ou d'informations qu'ils doivent recueillir pour permettre aux scientifiques, aux Autochtones et aux décideurs de mieux comprendre la question, ce qui favorisera la mobilisation de fonds à l'avenir.

Pour les besoins de l'IEN, le Nord canadien peut se définir comme la région comprenant le Yukon, les Territoires du Nord-Ouest, le Nunavut, les basses terres des baies d'Hudson et de James en Ontario et au Manitoba, le Nord du Québec et le Labrador (figure 3). Cette région englobe un certain nombre d'écozones, comme le bouclier et les plaines de la taïga, le sud et le nord de l'Arctique, la cordillère boréale et la cordillère arctique. Chacune de ces zones présente des caractéristiques particulières au niveau de la flore et de la faune et est peuplée de manière variable.

QUESTIONS RÉGIONALES CERNÉES DANS L'ÉTUDE PAN-CANADIENNE

On trouvera ci-après un résumé général des incidences possibles des changements climatiques résumées dans les différents tomes régionaux de l'Étude pan-canadienne (EPC) au sujet des secteurs de la région qui intéressent l'IEN. Le gros des informations figure dans le chapitre sur l'Arctique. Les données sur les autres régions (Pacifique et Yukon, Ontario, Québec et Atlantique) ne sont pas aussi détaillées, car ces volumes se concentrent davantage sur les régions peuplées du sud. Il n'en reste pas moins que les chapitres ont été analysés et qu'on a résumé leurs résultats qui présentent de l'intérêt pour l'IEN.

Yukon (tome I de l'EPC)

Un certain nombre de changements possibles ont été cernés dans le Yukon qui risquent d'avoir de sérieux impacts sur le plan écologique. Mentionnons notamment : a) une élévation de 50 cm du niveau de la mer sur la côte nord du territoire qui transformera le littoral et les terres humides côtières; b) des variations dans la fréquence et l'ampleur des phénomènes d'inondation et de sécheresse dans la région, ce qui entraînera des changements dans les habitats aquatiques; c) en raison d'une hausse des précipitations et des températures hivernales, on risque de voir augmenter la fréquence des glissements de terrain, la dégradation du pergélisol, le retrait des glaciers; d) on escompte des changements dans les types forestiers qui s'accompagneront d'un décalage vers le nord de la limite de la zone arborée; e) on anticipe l'extinction possible d'espèces vulnérables et la modification de la capacité de reproduction des espèces migratoires.

Territoires du Nord-Ouest et Nunavut (tome II de l'EPC)

Au cours des cent dernières années, le district du Mackenzie a connu un réchauffement de 1,5 °C, la toundra arctique de 0,5 °C, alors que la région des montagnes et des fjords de l'Arctique à l'est de cette région a subi un léger refroidissement. Parmi les prévisions d'avenir : l'hiver, on prévoit un réchauffement de 5 °C à 7 °C de la masse continentale et d'une bonne partie des îles de l'Arctique, moyennant un modeste refroidissement de l'extrême est de l'Arctique et une augmentation de l'humidité du sol. L'été, on prévoit un réchauffement pouvant atteindre 5 °C sur

la masse continentale, mais à peine 1 °C à 2 °C sur les secteurs maritimes. Les précipitations annuelles augmentent de jusqu'à 25 %, ce qui fait que les précipitations solides du début de l'automne ou du printemps tombent désormais sous forme liquide.

Aux latitudes élevées, comme dans l'Arctique canadien, tout porte à croire que la taille des glaciers et calottes glaciaires subira peu de changements. L'augmentation de la fonte estivale aux basses altitudes sera sans doute neutralisée par celle de l'accumulation à plus haut niveau. Le réchauffement de l'atmosphère et l'allongement de la période de dégel feront monter l'évaporation dans l'Arctique canadien. Sur les terres, les pertes par évaporation seront réglées par la nouvelle couverture végétale. Les récentes recherches menées dans le bassin du Mackenzie portent à croire que l'évapotranspiration y augmentera. On s'attend à ce que les cours d'eau coulant vers le Nord subissent une baisse des débits et des niveaux. La saison des glaces fluviales pourra durer jusqu'à un mois de moins en 2050 et jusqu'à deux semaines de moins en ce qui concerne les grands lacs.

Plus de la moitié de la zone de pergélisol discontinu devrait disparaître à terme. Le décalage vers le nord de la limite entre les pergélisols continu et discontinu se chiffrera en centaines de kilomètres, mais on ne sait pas encore où ni quand elle se stabilisera. L'épaisseur de la couche active augmentera lentement dans la zone de pergélisol discontinu pour atteindre peut-être le double de sa valeur actuelle.

Un relief thermokarstique prononcé et une accentuation de l'érosion sur le littoral sont à prévoir. On escompte une fréquence accrue des glissements de terrain de faible épaisseur. Les glaces marines seront moins présentes dans le nord et l'ouest. On prévoit un amincissement d'environ 0,5 m de la banquise côtière l'hiver dans le passage du Nord-Ouest (que risque néanmoins de tempérer l'épaississement du couvert nival) et un allongement de un à trois mois de la saison sans glace. La saison d'eau libre, actuellement d'environ 60 jours, devrait atteindre 150 jours dans la mer de Beaufort. L'extension maximale de l'eau libre l'été, actuellement de l'ordre de 150 km à 200 km, se situera entre 500 km et 800 km. L'épaisseur maximale de la glace de l'année diminuera de 50 % à 75 %. On prévoit également une diminution de l'épaisseur du crêtage de la glace de l'année et de la fréquence d'incursion de la vieille glace (dans la mesure où le régime des vents n'est pas modifié).

Parmi les incidences possibles de ces phénomènes sur les écosystèmes naturels :

a) On prévoit que la superficie des grands biomes arctiques actuels changera comme suit : pour la glace, une réduction de 12 % à 24 %; pour la toundra, une réduction de 31 % à 58 %; pour la taïga, une augmentation de 16 % à 35 %. La composition des écosystèmes changera (plus d'arbustes et de végétation tolérant l'humidité, et moins de plantes non vasculaires) tandis que la diversité des espèces diminuera. Le rétrécissement du biome de la toundra arctique s'accompagnera du décalage vers le nord de la limite de la zone arborée qui pourra remonter de 750 km dans l'est de Keewatin. Une augmentation des feux de forêts et de la présence d'insectes et un allongement de la saison de croissance devraient entraîner des modifications notables de la végétation dans le bassin du Mackenzie.

b) Les insectes aujourd'hui courants dans le sud du Canada atteindront le secteur du bassin du Mackenzie. De même, les ravageurs qui se trouvent déjà dans la région migreront non seulement vers le nord, mais également en altitude.

c) Faune terrestre – Dans l'Arctique, ce sont les effets indirects du réchauffement planétaire sur la disponibilité de la nourriture et de l'eau qui toucheront le plus la faune. Si le fourrage n'est plus disponible aux mêmes moments et dans les mêmes quantités, et que les infestations de parasites subissent le même genre de modification, il risque de s'ensuivre un déclin des populations animales, situation qui affectera gravement les populations humaines qui en dépendent encore. Les caribous de Bathurst qui vivent au nord du Grand lac des Esclaves seront probablement plus maigres, en partie à cause de l'épaississement du couvert nival, en partie à cause d'une augmentation de la nuisance causée par les insectes piqueurs. Au nord du continent, les populations de caribou de Peary et de bœuf musqué du haut-Arctique pourraient bien s'éteindre. Les relations prédateur-proie, élément critique des cycles biologiques des espèces arctiques, seront modifiées aux endroits où les distributions du couvert nival et du type de neige changeront. L'habitat d'été des oiseaux de rivage du delta du Mackenzie ne changera probablement pas beaucoup; dans l'ensemble, les changements prévus dans les conditions climatiques et environnementales devraient être plus néfastes que bénéfiques pour les oies.

d) Eaux douces et de mer – Les températures des lacs monteront, mais l'effet de cette situation sur les habitats des poissons dulcicoles reste incertain. Les espèces d'eau froide pourraient être plus menacées, car on ne connaît pas complètement leur potentiel d'adaptation. De nombreuses espèces

des lacs et cours d'eau migreront probablement vers le pôle d'environ 150 km par degré Celsius d'élévation de la température de l'air. On verra un changement de la distribution et des caractéristiques des polynies (zones sans glace, comme l'eau du Nord, à l'extrémité nord de l'île de Baffin, le Hell Gate entre les îles Devon et Ellesmere, dans le bassin Foxe au large de Hall Beach, et dans le détroit de Penny) et des lisières des glaces qui sont vitales aux écosystèmes marins de l'Arctique. Les incidences de cette situation sur les mammifères comme les ours polaires, les baleines et les phoques, ou sur les oiseaux de mer, risquent d'être à la fois positives et négatives, même au sein d'une même espèce. L'aire de répartition et les effectifs de certains mammifères marins de l'Arctique, comme le béluga et la baleine boréale, pourraient augmenter ou, dans le pire des cas, rester stables. Le phoque annelé, le phoque barbu, le lion de mer et le morse ont besoin de grandes étendues de glace pour se reproduire, se nourrir, etc.; un rétrécissement de la banquise risque donc d'entraîner une baisse de leurs populations. Par ailleurs, certaines espèces (comme la loutre de mer) peuvent être avantagées si elles gagnent de nouveaux territoires comportant moins de glace de mer. Pour les ours blancs, les conséquences risquent d'être graves; un allongement de la saison sans glace peut accroître le stress nutritionnel sur la population de la baie d'Hudson, jusqu'au point où les individus risquent de ne plus pouvoir stocker assez de graisse pour survivre. Si la saison sans glace de l'océan Arctique s'allonge, il y a fort à parier que l'ours blanc s'éteindra.

Nord de l'Ontario, basses terres de la baie d'Hudson (tome IV de l'EPC)

Cette région de vastes terres humides n'a guère été étudiée sur le plan des changements climatiques. La hauteur régionale de la nappe phréatique peut varier selon la saison à cause d'un changement dans le synchronisme des précipitations et de l'évaporation. Cela risque d'entraîner des changements dans les émissions de gaz à effet de serre. Il se peut également qu'une modification de l'état des glaces dans la baie d'Hudson provoque des transformations à grande échelle dans les aires d'hivernage de l'ours blanc.

Nord du Québec (tome V de l'EPC)

Le Rapport régional de l'Étude pan-canadienne a recensé un certain nombre de questions

au sujet du Nord du Québec et des changements climatiques. Commençons par mentionner une connaissance très insuffisante de la variabilité hydrologique d'une région fortement utilisée pour la production d'hydroélectricité. Cela affecte directement les habitats du poisson et de la sauvagine. Cela risque également de toucher les couloirs de migration du caribou et d'autres espèces fauniques. On sait par ailleurs peu de choses des facteurs climatiques qui ont une incidence sur les populations naturelles de végétaux et d'animaux. Le présent rapport recommande d'étudier les étapes critiques du développement d'espèces importantes sous l'angle de leur sensibilité au climat, en particulier des poissons d'eau de mer et d'eau douce.

Le pergélisol dans le Nord du Québec est préoccupant sur le plan écologique car il est présent dans une bonne partie de cette région et il contient des populations végétales et animales uniques en leur genre. Le rapport contient une recommandation en vue d'améliorer le réseau existant de mesures thermiques du sol.

Labrador (tome VI de l'EPC)

Le Labrador suscite un certain nombre de préoccupations analogues à celles du Nord du Québec, vu que les deux régions font partie de la péninsule d'Ungava. Les ressources hydriques de la région sont exploitées pour la production d'hydroélectricité, ce qui a des impacts sur les écosystèmes d'eau douce. Les troupeaux de caribous ont des comportements migratoires qui sont fonction des variables climatiques et des changements saisonniers qui se produisent dans leurs écosystèmes. Le Labrador possède également un vigoureux système côtier qui abrite de vastes colonies d'oiseaux de rivage, des troupeaux de phoques et des espèces de poissons exploités par la société.

RÉSULTATS DU SONDAGE MENÉ AUPRÈS DES CHERCHEURS

Pour tenter de mieux comprendre les préoccupations des chercheurs et des organismes subventionnaires, nous avons adressé par courriel un questionnaire à un vaste groupe de chercheurs du milieu universitaire et du gouvernement dans tout le Canada. Nous avons reçu 71 réponses qui nous ont permis de déterminer l'ampleur des recherches qui se font aujourd'hui et les principales préoccupations des scientifiques qui font de la recherche. Chacune des recommandations émanant de ce questionnaire figure à l'annexe B. Les réponses à ce questionnaire permettent de dégager quelques grands thèmes qui sont résumés ci-après. Ils ne sont pas énumérés par ordre d'importance, car ils sont interdépendants et qu'ils touchent un certain nombre de thèmes importants en soi.

a) Le premier thème est la pénurie de données sur les espèces « clés » ou indicatrices du Nord et sur l'effet que les changements climatiques peuvent avoir sur elles. Cela semble être le cas des écosystèmes d'eau douce, des éléments du paysage (sols, flore) ou des espèces fauniques. Un certain nombre de remarques incitent également à croire qu'on manque d'informations à la fois sur les écosystèmes biotiques (p. ex. prévisions démographiques) et les écosystèmes abiotiques (p. ex. température, précipitations), lesquelles devraient fournir un niveau de référence précis sur le lieu d'existence de ces écosystèmes pour autoriser leur suivi à long terme et estimer les changements dont ils sont l'objet. Peut-être pourra-t-on utiliser les études paléolimnologiques sur l'Holocène pour obtenir certaines de ces données.

b) Le deuxième thème qui se dégage de ce questionnaire est l'importance qu'il y a à utiliser les connaissances ancestrales pour savoir sur quels éléments des écosystèmes il y a lieu de se concentrer. Cela suit deux axes de raisonnement. Le premier veut que certaines populations végétales et animales revêtent une importance cruciale pour la survie des personnes qui vivent dans une économie de subsistance. Deuxièmement, les gens qui vivent de la terre sont beaucoup plus sensibles aux légers changements qui affectent leur environnement et en sont plus conscients. Ils

peuvent donc permettre au milieu scientifique de mieux comprendre les indicateurs des changements environnementaux.

c) Le Canada est un pays très vaste. Si certaines régions de l'Ouest de l'Arctique se réchauffent, l'est de l'Arctique se refroidit en revanche. Il importe de comprendre et d'expliquer ces différences dans le contexte national. Cela nous apprend par ailleurs qu'il est souvent impossible de faire des généralisations sur les changements climatiques dans le Nord. En effet, des constatations qui s'appliquent à une partie de la région, mais pas à une autre, risquent d'être mises hors contexte par des parties mal informées ou conflictuelles, si nous ne recueillons pas d'informations pour tenter d'expliquer ce qui ressemble à un écart. C'est là que réside l'importance du rôle des modélisateurs climatiques et des climatologues.

d) Quatrièmement, il faut absolument avoir accès aux bases de données existantes et interprétées ou, du moins, savoir qu'elles existent. Mentionnons entre autres les données climatologiques, hydrologiques, énergétiques, les photographies aériennes de même que les relevés biologiques. Les produits de la télédétection sont mal connus des chercheurs d'autres domaines et doivent donc être identifiés et expliqués à des non-spécialistes.

e) On a suggéré plusieurs études interdisciplinaires pour étoffer nos connaissances sur les rapports entre le climat et les écosystèmes dans le Nord, lesquelles ne relèvent pas des principaux axes énumérés ci-dessus : mentionnons notamment les interactions feu-forêt, les interactions terrestres-aquatiques et les interactions glaces-écosystèmes.

ANALYSE DES RECHERCHES BIBLIOGRAPHIQUES

Cette bibliographie vise deux grands objectifs. Le premier est de cerner les principaux sujets qui ont été étudiés par les chercheurs par le passé au sujet du climat ou des changements climatiques dans le Nord. Les sujets ont maintenant été recensés et un bref résumé est fourni à propos du contenu du titre de chaque rapport. La bibliographie ne se veut certes pas exhaustive.

Elle vise à se faire une idée de ce qui a été fait et par qui, informations dont ont besoin les gestionnaires de l'IEN pour établir leurs priorités de recherche. Cela signifie que l'interprétation vise l'utilité des informations dans l'optique des sciences écosystémiques. Cela signifie également que les résumés ne décrivent pas le contenu de la section pour le spécialiste du secteur visé. Cela déborde en effet le cadre du présent rapport, sans compter que son auteur n'a pas les compétences voulues pour s'aventurer dans des domaines qui n'appartiennent pas à sa sphère d'expertise. Le deuxième but est de fournir aux chercheurs un point de départ lorsqu'ils entreprennent leurs recherches dans un nouveau domaine. Cela devrait permettre aux chercheurs qui connaissent mal le domaine de se faire une idée de ce qui a été fait et des ouvrages qu'ils peuvent consulter à ce sujet.

Nous avons contracté un abonnement à un service bibliographique fourni par la National Information Services Corp. de Baltimore (Maryland). Celle-ci a constitué une base de données sur les régions de l'Arctique et de l'Antarctique qui contient près de 800 000 références aussi bien dans les revues scientifiques que non scientifiques. Cette base de données est actualisée chaque trimestre à partir d'un certain nombre d'autres bases de données consultées depuis l'Université de Calgary jusqu'à la Library of Congress des États-Unis. Nous avons consulté la base de données au moyen de mots clés comme climat, changements climatiques, Arctique ou subarctique, et de termes secondaires comme atmosphères, côtier, forêts, eau douce et limnologie, hydrologie, peuples, sols, terres humides et faune.

Voici comment nous avons procédé pour cette section : nous avons interrogé la base de données la plus récente de NISC intitulée Discover™ Arctic and Antarctic Publications (mai 1999) en utilisant une série de mots clés afin d'extraire tous les rapports et les articles possibles contenant les mots climat et Arctique dans les 800 000 références. Cela signifie qu'un grand nombre de rapports et d'articles qui ont peut-être un rapport avec le climat et les changements climatiques ne sont pas inclus à cause de l'absence des mots clés utilisés. Les articles extraits ont été classés par catégories qui sont énumérées ci-après. Nous avons cherché à éliminer au maximum les doublons dans les références, mais il y a fort à parier qu'on trouvera un certain nombre d'articles plus d'une fois. Il faut également souligner qu'un grand nombre des rapports sont déjà périmés. Nous n'avons pas cherché à les éviter vu que nous n'avons pas les compétences voulues

dans beaucoup des domaines analysés et qu'il nous est impossible de juger de ce qui est pertinent ou non en dehors de notre sphère d'expertise.

Parmi les types de rapports extraits, il y a des articles publiés dans des revues scientifiques, des livres, des rapports de données, des rapports techniques, des actes de conférences et des demandes de licence de recherche. Nous nous sommes efforcés de contrôler la qualité des entrées. La plupart des demandes de licence ont été éliminées de la liste, vu qu'il n'y avait généralement pas de suivi dans la section des rapports. Nous avons également jugé que le questionnaire sur les recherches en cours (autre section de ce rapport) tenait compte de ces types d'études. Il y avait également un certain nombre de résumés d'actes de conférences passées qui n'ont jamais donné lieu à la publication d'un rapport, et qu'on a jugés insuffisamment développés pour les inclure ici.

L'un des corollaires de la suppression des doublons est qu'il nous a fallu parfois user d'arbitraire pour ranger un rapport dans une catégorie particulière. Il faut en effet savoir qu'il y a un certain nombre de recoupements possible entre les catégories utilisées. Par exemple, la section sur la modélisation climatique contient un sous-groupe sur les impacts de la neige et de la glace sur les modèles. Il y a également une section distincte sur la neige et la glace qui contient des rapports qui n'ont pas un lien direct avec la modélisation dans leur titre. Comme autre exemple, disons que les études paléontologiques figurent dans une section distincte. Toutefois, les recherches sur les échantillons récents (p. ex. l'Holocène) continuent de faire partie de la section d'intérêt (foresterie, ressources dulcicoles), car elles ont un rapport avec le climat actuel.

Après un travail d'édition, de suppression des redondances et des résultats sans intérêt, notre recherche bibliographique a produit 1 085 références (voir annexe C). Il ne s'agit sans doute pas d'un résultat entièrement complet, même s'il nous donne la majeure partie des principaux ouvrages qui existent et qu'il fournit un échantillonnage valable des principales questions jugées importantes. Il y a également certains recoupements entre catégories, mais nous les avons maintenus pour assurer qu'aucune information n'était laissée de côté.

Il y a également un certain nombre de grandes sources d'information de nature trop générale ou trop détaillée pour figurer dans les sections distinctes de la bibliographie. Par exemple, « le Groupe d'experts intergouvernemental sur l'évolution du climat » a publié un certain nombre de rapports très détaillés qui comportent souvent des sections sur le Nord. Les rapports

suivants sont les principaux résultats de cet exercice :

a) GIEC, 1990a. Climate Change : The IPCC Scientific Assessment. J. T. Houghton, G. J. Jenkins et J. J. Ephraums, éd. Cambridge University Press, Cambridge, R.-U.

b) GIEC, 1990b. Climate Change : The IPCC Impacts Assessment. Cambridge University Press, Cambridge, R.-U.

c) GIEC, 1992a. Climate Change 1992 : The Supplementary Report to the IPCC Scientific Assessment (J. T. Houghton, B. A. Callander et S. K. Varney, éd.). Cambridge University Press, Cambridge, R.-U.

d) GIEC, 1992b. Climate Change 1992 : The Supplementary Report to the IPCC Impact Assessment. Cambridge University Press, Cambridge, R.-U.

e) GIEC, 1994. Climate Change 1994 : Radiative Forcing of Climate Change and an Evaluation of the IPCC IS92 Emission Scenarios. Cambridge University Press.

f) GIEC, 1996a. Évolution du climat 1995 : deuxième rapport d'évaluation sur l'évolution du climat. Cambridge Press, 572 pages.

g) GIEC, 1996b. Évolution du climat 1995 : impacts, adaptations et atténuation des changements climatiques : analyses scientifiques-techniques. Cambridge University Press, 878 pages.

À l'instar des rapports du GIEC, mais plus proches du Canada, il y a les rapports de l'Étude pan-canadienne sur les changements climatiques (résumés ci-dessus). Publiés sous l'égide d'Environnement Canada en 1998, les résultats de cet exercice national sont résumés dans un certain nombre de rapports publiés par le Secrétariat de l'Étude pan-canadienne d'Environnement Canada. On peut en trouver les résumés à l'adresse http://www.ec.gc.ca/ccs.

L'Étude pan-canadienne comporte huit tomes. Chaque tome décrit les données existantes et précise les lacunes au sujet de l'Atlantique (tome VI), du Québec (tome V), de l'Ontario (tome IV), des Prairies (tome III), de l'Arctique (tome II) et de la Colombie-Britannique et du Yukon (tome I). Il y a également un tome (tome VII) qui décrit les questions sectorielles (les ressources hydriques, les écosystèmes naturels et la biodiversité, les milieux humides d'eau douce, l'agriculture, les pêches, les forêts, l'énergie, les transports, l'environnement bâti, l'assurance,

la santé et les loisirs et le tourisme). Le dernier tome (tome VIII) traite des questions intersectorielles : dimensions économiques des mesures d'adaptation et des impacts résiduels au Canada, phénomènes extrêmes, évaluations intégrées des problèmes atmosphériques, influences extraterritoriales du changement climatique : ses effets à l'extérieur du Canada, changement climatique et mouvements des échanges et du commerce intérieurs au Canada, altération des paysages, développement durable, et le changement climatique et l'économie de subsistance des populations nordiques.

L'Étude d'impact sur le bassin du Mackenzie est une étude détaillée de ce bassin qui traite de tout un éventail de questions environnementales et socio-économiques, et qui comporte notamment un grand nombre de sections qui traitent directement ou indirectement des changements climatiques. Les sections particulières sont énumérées dans les sections bibliographiques présentant de l'intérêt, mais le résumé général et les renvois à tous les rapports figurent dans l'ouvrage suivant :

Cohen, S. [éditeur]. Étude d'impact sur le bassin du Mackenzie (EIBM) : rapport final. Downsview (Ontario). Division de la recherche sur l'adaptation environnementale, Direction générale de la recherche atmosphérique et climatologique, 1997, vii, 372 pages, ill. (quelques col.), cartes (quelques col.); 28 cm; 0-660-16973-8.

On trouvera un résumé du projet accompagné de données sur toutes ses parties constituantes à l'adresse Web : http://www1.tor.ec.gc.ca/earg/mbis/mackenzie.htm. Plusieurs sections du rapport traitent exclusivement du changement climatique. De plus, un certain nombre d'autres ressources informatives sont indiquées à l'annexe A.

REMARQUES SUR CERTAINES SECTIONS BIBLIOGRAPHIQUES

On trouvera ci-après une description générale des articles et des rapports que cette recherche a permis d'extraire. Comme nous l'avons vu plus haut, la description est de nature générale et vise essentiellement les interactions écosystème-climat. Elle ne s'adresse pas aux

spécialistes du domaine, même si ceux-ci y trouveront certainement des références qui leur seront utiles.

Prévisions et impacts climatiques généraux:

Cette section contient essentiellement des articles et des rapports généraux qui décrivent les résultats d'études ou des opinions sur la signification du changement climatique dans le Nord. Il y a également une bibliographie commentée sur les articles consacrés aux changements climatiques publiés depuis 1991 (Handel et Risbey, 1992), qui ne porte pas exclusivement sur le Nord, mais qui constitue un bon point de départ pour les gens qui s'aventurent pour la première fois dans le domaine des changements climatiques. On ne peut pas en dégager de thèmes vraiment clairs car cette section est un recueil d'articles de nature essentiellement non technique qui s'adressent à un public assez nombreux.

Climatologie:

Les articles qui figurent dans cette section renvoient à des renseignements généraux qui peuvent servir aux études sur les écosystèmes. En particulier, on y trouve un certain nombre d'ouvrages qui résument ou qui expliquent les conditions climatiques dans diverses régions. La plupart portent sur les Territoires du Nord-Ouest et le Nunavut. Il y a un article récent sur le Labrador (Banfield et Jacobs) et un rapport périmé sur le Québec (C. Wilson). On y trouve des ouvrages généraux qui décrivent la climatologie du Nord. Il y a également des données sur la distribution des glaces marines et certaines études climatiques interprétatives qui décrivent l'influence de la glace, de la neige et des eaux libres. Dans l'ensemble, plusieurs de ces articles permettent de mieux comprendre l'environnement physique du Nord et fournissent des données utiles pour les écologues.

Climats anciens:

Pour mieux situer le climat qui règne de nos jours, il faut bien comprendre ce qui s'est

passé par le passé. Un certain nombre d'études ont cherché à définir ce à quoi ressemblait l'environnement du passé. Celles-ci utilisent souvent les démarches des isotopes et du CO_2 que l'on trouve au cœur des glaces, ainsi que le pollen et d'autres indicateurs. On a également parfois utilisé des carottes de sédiments lacustres. Dans l'ensemble, ces études permettent de situer les conditions actuelles dans un contexte géologique. Les études consacrées au passé plus récent, par exemple la fin de l'ère glaciaire, l'Holocène ou les recherches plus récentes sur les sédiments ou les glaces ont été classés dans les sections qui les représentent le mieux (eau douce, forêts, etc.).

Systèmes côtiers:

Peu d'articles ont été extraits par cette analyse. La plupart ont un rapport avec l'érosion du littoral. Il existe sans doute beaucoup plus d'informations sur les systèmes côtiers et marins dans le Nord et sur leurs rapports avec le changement climatique, mais ils n'ont pas répondu aux mots clés utilisés. Il importe peu de savoir s'il existe quelques rapports de plus dans le cadre de cette analyse. Ce qui ressort des quelques articles que nous avons trouvés, c'est qu'une attention minime a été portée à ce sujet qui pourrait revêtir une importance cruciale dans un monde où le niveau de la mer risque de s'élever de façon appréciable. Cela présente un grand intérêt dans la majeure partie du Nord, dont le gros du littoral est bas.

Les gens et la société:

L'être humain fait partie intégrante de l'environnement et il sera indéniablement touché par le changement climatique. Les rapports que nous avons extraits de la base de données ont pour la plupart trait à la façon dont les peuples autochtones se sont adaptés à l'environnement par le passé. Il y a un certain nombre d'articles historiques qui décrivent l'existence avant la colonisation. Il y en a également plusieurs qui étudient la façon dont les peuples autochtones s'adaptent à l'évolution du climat. La plupart portent sur les modes de vie traditionnels, comme la chasse au caribou. Un certain nombre traitent également du rapport entre les Inuits et le développement. Il y en a même un qui traite de l'incidence du changement climatique sur le tourisme dans le Nord.

Pour ce qui est de l'IEN, tous les articles font valoir que les ressources naturelles utilisées selon les modes de vie traditionnels seront touchées par l'évolution des écosystèmes, et qu'il en ira de même des habitants. Cela permet de s'assurer que l'IEN tiendra toujours compte de ces rapports étroits en établissant l'ordre de priorité des projets dont on cherche à obtenir le financement. De plus, les connaissances ancestrales offrent un certain nombre d'interfaces intéressantes avec les sciences conventionnelles, dont il faut tirer parti.

La faune et l'écologie générale:

La plupart des articles de cette section portent sur le rapport d'interdépendance entre divers groupes d'animaux et le climat. C'est ainsi qu'ils traitent des oies, des oiseaux de rivage, des grouses, des colonies de sauvagine et des canards, essentiellement dans les Territoires du Nord-Ouest. Il en va de même des mammifères. C'est ainsi qu'on a étudié le mouflon de Dall, le caribou, le bœuf musqué, les mammifères marins, le porc-épic, le lemming et l'ours blanc. Il y a également une étude intéressante sur l'utilisation du puceron lanigère comme indicateur du climat (Morewood). Les ouvrages publiés à l'extérieur des Territoires du Nord-Ouest sont rares, à l'exception de quelques-uns sur le porc-épic réalisés dans le nord du Québec.

Il y a d'autres données disponibles que nous n'avons pas pu extraire de la base de

données. Compte tenu des grands projets de développement réalisés ou prévus dans le Nord, il existe une quantité d'informations dans les études d'impact sur l'environnement qui pourraient être utilisées dans le cadre d'études fondamentales ou réinterprétées pour se faire quelques idées sur les rapports entre le climat et la faune.

Écosystèmes d'eau douce:

Beaucoup d'études limnologiques ont été réalisées dans le Nord, dont une grande partie sont de nature exploratoire ou portent exclusivement sur les questions de productivité. Notre questionnaire a néanmoins fait apparaître un petit nombre d'articles. Ceux-ci traitent des sujets suivants : écologie générale (p. ex. Rigler), écologie des algues, analyses de la chimie des eaux dans les T.N.-O. et au Labrador, études paléolimnologiques (p. ex. Smol) et un certain nombre d'études sur les poissons.

Nous n'avons rien trouvé dans la base de données sur le Nord du Québec, même si un grand nombre d'articles et de rapports existent au sujet des projets de la baie de James, qui pourraient présenter un intérêt direct pour les études sur le climat. On pourrait en dire autant du Labrador et du Nord du Manitoba où les études sur l'hydroélectricité et d'autres projets de développement ont donné lieu à un grand nombre de données publiées et non publiées qui ont un rapport avec le climat.

Pergélisol et sols:

La plupart des articles de cette catégorie portent sur le pergélisol qui est, par définition, sensible au climat. Les articles portent sur la distribution, la dynamique saisonnière et les facteurs déterminants. Il y a un certain nombre d'articles consacrés aux terres humides pour le traitement des eaux usées et d'autres aux habitats. D'autres encore traitent de la formation des sols dans le Nord. Enfin, deux articles (Brklavich et Mills) traitent de l'agriculture dans la région.

Terres humides et gazes de serre:

La plupart des articles de cette section pourraient être classés dans les sections sur le

pergélisol/terres humides ou les forêts, mais nous avons voulu les mettre dans une section distincte car leur orientation est très spécifique. Ils traitent de la quantification des échanges de CH_4 et de CO_2 entre les sols et l'atmosphère. On sait que les écosystèmes du Nord sont de très vastes réservoirs de gaz à effet de serre (GES). Un certain nombre d'études ont révélé que ces puits risquent d'avoir une incidence profonde sur les cycles mondiaux des GES; aussi avons-nous décidé de les mettre dans une catégorie distincte pour faciliter l'utilisation de la bibliographie. Les recherches sur les GES sont actuellement financées par deux autres organismes du gouvernement canadien, le Groupe interministériel de recherche et d'exploitation énergétiques (GRED) et le Fonds d'action pour le changement climatique (FACC).

Végétation et forêts :

Les principaux thèmes qui se dégagent de ces articles sont la distribution de la végétation dans le Nord et ses rapports avec le climat et les feux de végétation. Un certain nombre d'articles analysent également les transformations possibles que subit la forêt du Nord à cause des changements climatiques. Les feux sont un facteur déterminant du contrôle de la distribution des végétaux et de leur composition, sans oublier le rôle de la forêt boréale dans le cycle mondial du carbone. Nous avons également extrait des articles qui décrivent les problèmes que pose l'exploitation forestière dans le Nord, le cycle des éléments nutritifs, sans oublier des études sur la productivité et l'énergie. Les articles consacrés à la distribution de la végétation traitent de la limite de la zone arborée et des changements qui l'affectent de même que de la situation écologique générale des végétaux dans la région. La plupart des articles proviennent des T.N.-O., et quelques-uns d'entre eux décrivent la situation qui prévaut dans le Nord du Québec.

Hydrologie:

Cette catégorie a été subdivisée en sous-catégories qui sont l'eau, la glace et la neige, car les questions dont traitent ces articles sont légèrement différentes.

Eau :

Il y a deux grandes catégories d'articles dans ce groupe. D'une part, les rapports qui décrivent les conditions hydrologiques du Nord, de l'autre, les articles qui examinent les changements que le climat entraînera sur l'hydrologie de la région. Le Nord du Canada est une vaste région qui recouvre toute une variété de conditions climatiques et géographiques, et la situation se prête à toutes sortes d'études préliminaires et descriptives dans le Nord. Un grand nombre d'articles ont été publiés qui tentent de prévoir quels changements l'évolution du climat aura sur les volumes d'eau de ruissellement et à quel moment dans la région. Certains articles abordent d'autres thèmes. Quelques-uns utilisent les méthodes isotopiques pour répertorier les sources et l'acheminement de l'eau. D'autres analysent les problèmes résultant de la production d'hydroélectricité, vu que le Nord du Canada est le lieu de quelques-uns des plus vastes projets d'hydroélectricité au monde. Il est clair qu'il existe un volume beaucoup plus élevé d'informations sur l'hydrologie s'appliquant aux changements climatiques, que ce que notre questionnaire a permis d'extraire.

Glaciers, neige et glace:

Ce groupe d'articles traite d'un certain nombre de thèmes. Certains analysent les bilans hydriques ou énergétiques dans les glaciers. D'autres se penchent sur les méthodes de quantification du couvert de neige et de glace dans de vastes régions (par satellite et par radar) ou examinent la distribution des éléments de la cryosphère. Plusieurs articles analysent la façon dont l'évolution du climat risque de modifier la formation des glaciers, des glaces et de la neige dans le Nord. Quelques-uns traitent directement des écosystèmes, mais présentent également de l'intérêt pour les études sur les végétaux et les animaux.

Modélisation climatique:

Un grand nombre d'articles traitent de l'élaboration des modèles climatiques. On les a subdivisés en articles généraux, en articles sur les océans, la glace marine, la neige et les glaciers, en articles sur les systèmes biologiques et sur les bilans énergétiques. Même si les résultats de la modélisation seront utiles aux chercheurs qui s'intéressent aux incidences écologiques, la plupart de ces articles ont pour but d'aider à concevoir des modèles améliorés. Beaucoup contiennent sans doute des renseignements utiles aux études sur les écosystèmes, mais, compte tenu des objectifs de la présente étude, ils ne feront pas l'objet d'une description plus détaillée.

Chimie de l'atmosphère:

Quelques articles traitent du transport des GES dans l'atmosphère. La plupart des articles de ce groupe nous rappellent toutefois que les GES ne sont pas les seuls gaz anthropiques qui ont des effets indirects ou directs sur les écosystèmes. L'ozone est un autre GES important qui a des ramifications écologiques. Un certain nombre des articles de ce groupe analysent la chimie de l'appauvrissement de la couche d'ozone stratosphérique, alors qu'un nombre plus restreint traite également de l'augmentation de l'ozone au niveau du sol (troposphérique). Un autre groupe traite des problèmes des particules aéroportées et des aérosols, lesquels ont une incidence sur l'estimation des bilans énergétiques de la planète, ce qui ne fait que compliquer la vie des modélisateurs climatiques. Enfin, un groupe d'articles analyse la chimie atmosphérique des micropolluants.

ANALYSE

Les Autochtones et les changements climatiques

Les divers tomes de l'Étude pan-canadienne tout comme les résultats de l'analyse bibliographique et du sondage mené auprès du milieu scientifique n'ont révélé que quelques

rapports publiés sur l'interaction des changements climatiques et des Autochtones. Le tome VIII, chapitre 8, de l'EPC, qui a pour titre « Le changement climatique et l'économie de subsistance des populations nordiques », en arrive à la même conclusion et contient un certain nombre de recommandations sur les besoins d'information. Cette pénurie de données est attribuable à un certain nombre de facteurs. Premièrement, le changement climatique est un champ d'étude relativement récent, ce qui incite à croire qu'une analyse approfondie de ses répercussions sur les peuples qui vivent de la terre n'a pas encore été réalisée, faute de temps. Des recherches s'imposent néanmoins, compte tenu des recommandations de l'EPC, pour mieux comprendre les effets que l'évolution des écosystèmes risque d'avoir sur les peuples autochtones.

Deuxièmement, un important volet des recherches sur l'impact des changements climatiques réside dans l'analyse de la dynamique des températures, des précipitations et des processus. Étant donné que le domaine est relativement récent, il existe peu de données quantifiables qui établissent un lien entre le mode de vie et les interactions des Autochtones avec la faune ou d'autres éléments de l'environnement. Enfin, les auteurs de l'EPC font valoir que les peuples qui vivent d'une économie de subsistance connaissent actuellement des transformations socio-économiques aiguës et très profondes. Il est donc difficile de recenser et de séparer les impacts que la variabilité et le changement du climat peuvent avoir sur eux, compte tenu des autres gros stress qui s'exercent sur leur mode de vie.

Il est clair que les peuples autochtones seront gravement touchés par les changements qui surviennent dans leur environnement, compte tenu de l'extrême interdépendance qui existe entre les deux. Il est clair par ailleurs que la connaissance intime qu'ils ont de leur environnement peut être d'un précieux concours pour les scientifiques qui cherchent à mieux comprendre les modifications subtiles qui touchent l'environnement. Il est donc éminemment souhaitable que les scientifiques (y compris les spécialistes des sciences sociales) collaborent avec les Autochtones pour recenser leurs principales vulnérabilités à l'évolution de l'environnement et déterminer de quelle façon les connaissances ancestrales peuvent être combinées à la démarche scientifique pour mieux comprendre l'évolution passée ou future des écosystèmes nordiques.

Manque de données scientifiques

Compte tenu de sa population clairsemée et du coût élevé des recherches dans le Nord, les informations environnementales dont on dispose sur cette partie du Canada sont beaucoup moins précises que celles sur la portion sud. L'analyse des incidences possibles ou réelles des changements climatiques est donc plus difficile et revêt un caractère plus spéculatif. Pour déterminer les changements que subiront diverses parties de l'écosystème, il est indispensable d'avoir des données de base sur les populations et les écosystèmes naturels. Or, ces informations sont une denrée rare qui risque de ne pas être disponible avant longtemps.

Le problème est accentué par le fait que toutes les régions du Nord du Canada ne seront pas touchées de la même façon. Par exemple, on prévoit que la région de la baie d'Hudson connaîtra le plus fort réchauffement global au Canada, alors que, sur la côte du Labrador (mais pas dans l'intérieur par contre), on s'attend à un rafraîchissement des températures annuelles. Par ailleurs, les MCG prévoient des hivers plus chauds pratiquement partout, ce qui avancera l'arrivée du printemps et retardera celle de l'automne et de l'hiver. On ne peut donc pas traiter le Nord comme une région homogène, qui subira un réchauffement général. Les différences qui existent dans les types d'écosystèmes entre les régions et les questions que cela soulève rendent également difficile l'adoption d'une seule approche.

Compte tenu de cette inhomogénéité, il est permis de se demander de quelle façon l'IEN peut apporter une contribution exceptionnelle aux connaissances sur les changements climatiques et leurs incidences sur le Nord du Canada. Un certain nombre de recommandations précises découlant des recherches sur les écosystèmes sont formulées dans les tomes de l'EPC consacrés aux différentes régions, et on en a dressé une liste plus haut. Il reste toutefois un certain nombre de problèmes que l'IEN devra aborder pour essayer d'améliorer l'état des connaissances sur les changements climatiques dans le Nord.

D'après notre analyse bibliographique et les remarques des chercheurs interrogés, il est manifeste que les rapports sont minimes entre les environnementalistes et les climatologues. La seule grande exception à cette assertion réside dans les recherches hydrologiques menées en vertu du GEWEX (Expérience mondiale sur les cycles de l'énergie et de l'eau) dans le bassin du

Mackenzie. Un resserrement des liens entre les écologues et les spécialistes des sciences atmosphériques : a) fournira aux écologues des données dont ils ont cruellement besoin sur les tendances mesurées et les prévisions climatiques qui existent déjà; et b) permettra aux modélisateurs de l'atmosphère de prendre conscience des besoins propres aux écologues afin de les aider à mieux interpréter leurs données. Ce type de besoin est en partie comblé par une subvention du Fonds d'action pour le changement climatique (FACC) octroyée au Groupe de travail sur l'adaptation au climat de l'Agence canadienne des services météorologiques. Toutefois, la proposition ne se concentre pas exclusivement sur le Nord et s'adresse à un groupe beaucoup plus nombreux que les experts en écosystèmes. L'IEN pourrait collaborer avec le groupe de l'Agence des services météorologiques afin de renforcer le débit des connaissances à l'intention d'un groupe d'usagers plus spécifique.

ANNEXE A

Autres Programmes, Initiatives et Sites Web Présentant De L'intérêt

Un certain nombre d'autres groupes s'intéressent aux changements climatiques dans le Nord et ont préparé des rapports, des programmes et des sites Web qui décrivent les incidences potentielles et contiennent des recommandations sur les recherches nécessaires, ou ont contribué des fonds pour la recherche. Dans cette section, nous dressons la liste d'un certain nombre de ces groupes.

a) Le Fonds d'action pour le changement climatique (http://climatechange.gc.ca/english/html/fund/index.html) est une initiative du gouvernement du

Canada dans le cadre de laquelle 150 millions $ seront débloqués sur trois ans, et qui prendra fin en 2000-2001. La majeure partie du financement vise la recherche technologique et la vulgarisation, même si un montant important est réservé à la modélisation des changements climatiques, à leurs incidences et à l'adaptation dans le Nord. Le site Web précise les projets qui ont été financés. Par exemple, 145 000 $ ont été versés à un projet réalisé dans le Yukon intitulé « Inuit Observations on Climate Change ». La liste de ces projets est constamment actualisée.

b) Le Comité international des sciences dans l'Arctique (CISA) se compose de représentants des pays circumpolaires. Ce comité a publié un rapport, « Impacts of Global Climate Change in the Arctic Region », qui contient également un certain nombre de recommandations générales qui ne sont pas sans rappeler les rapports du GIEC.

Nous avons également découvert un certain nombre de sites Web connexes. Voici un petit échantillon de ce qui est disponible et qui devrait fournir aux chercheurs un excellent point de départ.

c) http://www.eelink.net/~asilwildlife/wildlife.html : la faune, les écosystèmes et les changements climatiques, publié par la American Society of International Law.

d) http://www.ualberta.ca/~ccinst/polar/cci-base.htm : bulletin de nouvelles de l'Institut circumpolaire canadien, Polar Access. Le site Web de l'ICC donne des directives sur la façon de s'abonner en ligne à Polar Access.

e) http://www.pacinst.org/climate.html : construit par le Pacific Institute for Studies in Development, Environment, and Security. Il s'agit d'un institut indépendant à but non lucratif créé en 1987 pour mener des recherches et des analyses stratégiques dans les domaines de l'environnement, du développement durable et de la sécurité internationale. L'Institut vise trois grands objectifs : mener des recherches d'ordre stratégique sur la sécurité internationale, la transformation de l'environnement et le développement économique et social; collaborer à des

recherches complémentaires avec d'autres organismes et citoyens; et trouver des solutions avec les décideurs, les activistes et le grand public.